ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Vol. XXIV. No. 37.

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A NEW TYPE OF COMPOUND LOCOMOTIVE has been proposed by Messrs. MALLET, of Paris, and BRUNNER, of Munich. There are but two cylinders placed tandem under the center of the boiler between the drivers, the low-pressure cylinder being in front. The piston rods are split in order to pass the axles of the drivers, and end in cross-heads working in guides over the pony trucks at each end of the locomotive. The cross-heads are joined by connecting rods running backward toward the center of the engine, to the crank-shaped axles of the drivers. The designers claim that in this way the injurious effects of the reciprocating parts and counter-weights are greatly reduced.

ELECTRIC HEADLIGHTS will be used hereafter on the passenger trains of the Louisville, New Albany & Chicago Ry., according to the *Electrical Review*. Contracts have been let for equipping the 3 locomotives that haul the night trains between Indianapolis and Chicago and the 5 engines that run the night express between Chicago and Louisville.

THE M. C. B. AUTOMATIC COUPLERS are in greater favor than ever on the New York Central since the recent strike. The cars of this road are now pretty well equipped with M. C. B. couplers, and this was found to be a great help to the new employés in handling cars. As is well known, the greatest trouble during the strike was experienced in the yards, and the measure of relief afforded by the automatic couplers was considerable. A point of some importance in this connection is that the stealing of coupling pins is avoided by the use of the M. C. B. coupler, and such stealing in times of strike is very apt to be done from malicious motives, as well as at all times from cupidity.

THE AUSTRIAN ZONE PASSENGER TARIFF SYSTEM described in ENGINEERING NEWS of July 12, has proved so successful that a similar plan will be adopted on the Belgian railways. As the fares in Belgium are already the cheapest in Europe it is probable that the rates will become remarkably low under the zone system.

THE BUFFALO TERMINAL IMPROVEMENTS still make little progress. There is more prospect than heretofore, however, of agreement between the New York Central and the Erie, and if this is secured work may start soon. The present indications are that the plans when carried out will be much less complete than is desirable.

THE WORST ACCIDENT OF THE WEEK was a serious rear collision of the second section of a freight train with the first section, at the rear of which there were two carloads of laborers, on a curve near Florence, Colo., on the Denver & Rio Grande road, Sept. 6. The collision occurred from pure negligence in not sending back to flag the second section, only 10 minutes behind, after a derailment. Of the 50 laborers in the two cars 5 were killed at once, 37 injured, 6 of them fatally, and only 8 escaped outright. A collision occurred at the same point two months before. The engine crew escaped by jumping. Several despicable attempts at train wrecking have occurred on the New York Central road, as a result of the strike, but fortunately without any very serious results. The attempts have been unusually vicious and determined however.

A BRIDGE FAILURE, of a wooden span about 75 ft. long, on the Richmond & Danville R. R., Sept. 6, dropped an engine and 35 freight cars into the river. The span was a "handsome new one," the second of a series of four, and it appears to have been a dead fall, without provocation, although it was claimed after the event that some part of the engine truck was found broken. On the other hand, a head collision, due to a misplaced switch on the upper bridge at Albany, N. Y., failed to injure the bridge though the engines were badly damaged and three cars derailed and broken. A trestle work at Bridgewater on the Baltimore Central R. R. failed under a stone train Sept. 5, and dropped a number of cars into the river. A small highway bridge at Castleton, Va., failed Sept. 3, under a 5-ton load of stone.

A TERRIFIC BLASTING DISASTER at Spokane Falls, Wash., Sept. 6, resulted from the premature explosion of 200 lbs. of giant powder in a blast, burying 16 men (it was at first said 45) under over 700 cu. yds. of rock. The explosion is supposed to have resulted from careless tamping. The breast was 20 ft. high, in an excavation for the new freight yards. About 30 men were directly under the breast, and all but one or two were killed. The precise circumstances are not very clearly detailed in the report.

THE ANDERSON SYSTEM OF TUNNELING is employed in building the 15-ft. drainage sewer for which Anderson & Barr are the contractors. A pilot tube of iron plates, about 6 ft. in diameter, is pushed ahead of the masonry already in place, the earth is excavated around this pilot and whatever bracing is necessary, is done by posts resting against the iron plates and projecting radially like the spokes of a wheel. This method of construction reduces the number of struts to a minimum and hence gives plenty of working room.

THE ERIE SHIP CANAL COMMISSION has taken the first steps toward the preparation of the report that is to be made to the Pennsylvania Legislature regarding the canal from Pittsburg to the Great Lakes. The surveyors report that two lines are possible, one in the Allegheny Valley, the other along the Beaver River. The latter route is said to be the better. The distance from the Ohio River to Lake Erie would be some 125 miles by this line, but as 60 miles of the Beaver River are now navigable, there would be only half of the total length to be constructed.

THE SUEZ CANAL is in a very prosperous condition according to the recent annual report of Count DE LESSEPS. It is stated that the gross receipts were $13,800,000, and the expenditures, with interest at 5%, $6,400,000, leaving a balance of $7,400,000 available for dividends. Extensions and renewals at a cost of $1,920, 000 have been made, leaving $2,600,000 still in the treasury, of the sum appropriated in 1886. The minimum depth of water is now 26 ft. During the last year, 3,425 vessels with a 6,783,187 tonnage passed through the canal, yielding a revenue of $12,882,400. Since the installation of the electric lighting plant, 71% of the vessels have passed through in the night, only 41% or thereabouts, having passed through in the night before.

A SHIP CANAL TO PARIS has been projected by M. JULES GUYOT, the French Minister of Public Works. A commission of engineers has been appointed to inquire into the practicability of the enterprise.

A NEW 30-IN. INTAKE FOR THE EVANSTON, ILL., WATER-WORKS is being laid to a point 2,600 ft. out in Lake Michigan, in 26 ft. of water. Near the shore the pipe was laid in sand bars, in trenches 6 ft. deep made under the water. The remaining distance the pipe rests on a gravelly bottom. The pipe is laid from pontoons, in 48-ft. sections, caulked on shore, closed at the ends and towed into position. The joints between the sections are made under water with cold lead. As high as 96 ft. a day have been laid in deep water, with good weather. JOSEPH G. FALCON is Engineer of the work. We are indebted to S. B. PEENEY, Superintendent and Chief Engineer of the water-works, for the above data.

THE IRRIGATING DUTY OF WATER varies considerably, as may be seen from the following figures taken from a paper read before the Denver Society of Engineers by Mr. G. C. ANDERSON: In Spain, the duty is 35 acres per cu. ft. per second in Valencia for rice cultivation, or 101 acres per cu. ft. per second for general crops; in Granada, it was 286 acres per cu. ft. per second; in Elche and Lorca the duties are enormous, being 1,072 and 2,200 acres, respectively. In India a duty of 240 acres was obtained on the Ganges Canal, while 250 acres was reached on the Eastern Jumna Canal. In the older canals of Colorado a duty of 55.5 acres per cu. ft. per second was usual, but now this has risen to at least 100 acres, and Mr. MAXWELL, the State Engineer, is authority for the statement that the duty can be made 330 acres per cu. ft.

THE MISSISSIPPI LEVEE PROBLEM has been receiving a great deal of attention in the South and Southwest since the floods of last spring, which were of unexampled extent and overflowed an enormous area. In a recent issue the New Orleans *Times-Democrat* gives a history of levees in the States of the lower Mississippi from the construction of the first rude levee at New Orleans in 1718 to the recent breaks and floods in 1890. A map in the issue of the paper containing the history of the levees shows the alluvial portion of Louisiana overflowed in March, April and May, 1890, together with the name and location of each crevasse. The map was compiled by W. J. HARDEE and B. J. OLIVEIRIA, of the United States Engineers' office, and is a very striking one.

THE RIVER & RAIL ELECTRIC CO.'S SYSTEM OF STREET CAR PROPULSION is being practically tested on the road between Brooklyn and Fort Hamilton. The cars are said to move with great smoothness and to be perfectly under the control of the driver. A full description of the motors and storage batteries used by the company, which is considered to have a system of much promise, will be found in ENGINEERING NEWS of Dec. 7, 1889, and Sept. 6 1890.

A COMPOUND PROPELLER BLADE consisting of a sheathing of bronze or delta metal cast on a steel core has recently been patented in England. The advantages of bronze propeller blades, says *Engineering*, have long been recognized. Such blades can be cast with finer edges, which will, moreover, last the whole life of the blade, and have a much smoother surface than steel or cast iron blades. In spite of this, however, their adoption is still limited to war vessels and fast passenger steamships, as the ordinary ship owner does not care to face the heavy first cost of the bronze, in spite of the fact that it is worth a considerable percentage of its original cost as scrap at the end of its useful life. This new compound propeller will considerably reduce this first cost, as the steel core makes up a large part of the total weight of the blade. The union between the two metals is very perfect, an actual test showing that a tensile stress of 15 tons per sq. in. was required to separate the metals. The new blade would seem to possess all the advantages of the whole bronze blades at a considerable reduction in the cost of these.

A LONG HELIOGRAPH LINE connecting 25 stations, and in all over 1,000 miles in length, has been in successful use this summer from Fort Stanton in Mexico to Whipple Barracks in Arizona, between mountain peaks 40 to 45 miles apart, using a mirror about 4 ins. in diameter with an intercepting shutter. It has been demonstrated that the instrument is quite effective over distances as great as 95 miles.

A FIELD TELEPHONE LINE, a mile or so of wire, being carried on a knapsack reel on a man's back, with a receiver, transmitter and key ingeniously arranged in a small sole-leather pouch, is one of the latest developments of the signal office. It is chiefly designed for use in the field of battle.

Tests of the Baldwin Compound Locomotive.

(*Concluded from page 216.*)

MEASUREMENT OF WATER CONSUMED.

The quantity of feed water used was determined by measuring from time to time the depth of water in the tank and taking account of that added at each filling. Various precautions were taken to insure correct readings by this method. The depth of water was determined by two graduated water glasses, one on each side, set opposite the center of gravity of the horizontal cross section of the tank. The readings of the two were averaged. Thus the true depth of water was determined without regard to the grade of the track or the relative level of the two rails.

At the time the tank gauges were read the level of the water in the boiler was determined by reading a glass water gauge in the cab, while the inclination of the boiler was found by observing a plumb line attached to the front end of the frame. The tank of each engine was calibrated, and it was found that the capacity was 620 lbs. per in. depth.

To prevent loss of water from the injector overflow a device was provided for the reception of the water, from which it flowed by gravity back into the suction pipe of the injector.

METHOD OF OBTAINING THE INDICATOR DIAGRAMS.

We quote from the report as follows:

On the first series of tests one indicator was applied to each cylinder. The indicator pipes (¾-in. diameter) were attached to the two cylinder heads, and carried over by means of easy bends in the pipes to a central point above the cylinder, where they were attached to a three-way cock to which the indicator was applied. On the compound engine the pipes for the low-pressure cylinder were carried up to nearly the same level as those for the high-pressure cylinder, and they were consequently of greater length. The distance along the pipe from the cylinder to the three-way cock was about 3 ft. for the high-pressure cylinder and 4 ft. for the low-pressure cylinder. By this arrangement of pipes the indicators for the two cylinders were located nearly side by side, in a convenient position for handling and for being worked from a single driving rig. The pipes were securely braced to the cylinders.

The driving rig for the two indicators on each side consisted of a pendulum, suspended from the under side of the running board, which was worked by a short rod connecting the lower end to the cross-head. The upper end of the pendulum was provided with the sector of a circle, from the edge of which the driving cords led to the instruments. The length of the pendulum was 35½ ins., from center to center, and the radius of the sector was 4½ ins. Braided linen cords were used for the driving connection, the length of which, from sector to indicator, was about 6 ft.

On the second series of tests a successful attempt was made to avoid the use of long pipes by connecting the front ends of the two cylinders to one indicator, using as before ¾-in. pipes with easy bends, and a three-way cock; and the same arrangement was carried out for the crank ends. By this means the length of the pipe from the three-way pipe to the high-pressure cylinder on the crank ends was reduced to 8 ins., and on the low-pressure cylinder to 18 ins.; and the corresponding distance for the front ends was about 12 ins. for each cylinder. The linen cord was used for driving the crank end indicators, having a length of about 4½ ft., and a brass wire having a length of 8 ft. was used for driving the front end instruments. With this arrangement of pipes the high-pressure diagram of one end and the low-pressure diagram of the same end (which, however, was made by steam exhausted from the *opposite* end of the high-pressure cylinder) were both taken on the same blank and with the same spring.

The front end of the smoke-box and the cylinders were enclosed by means of a tight wooden fence about 3 ft. high, extending up from the level of the top of the cow-catcher. The bottom of the inclosure was floored in.

The indicators used on the tests were two of the Crosby pattern, which were employed on the right-hand cylinders, and two of the Tabor pattern, which were employed on the left-hand cylinders. The springs of the indicators had been tested, and their scales verified for steam pressure. The instruments were fitted with metallic marking-points, and paper was employed with the surface prepared for the use of this style of pencil.

During the running time of the first series of tests on the compound engine, full sets of diagrams were taken from each cylinder as fast as the two operators could handle the indicators, one operator being stationed on one side of the engine, and another on the opposite side. The first set of cards after starting from the stations was taken when the train had proceeded a quarter of a mile or thereabouts. The rapid motion of the air and the jolting of the engine produced by its high speed laid serious obstacles in the way of taking cards in rapid succession. These obstacles were so far overcome, however, that on the first series of tests of the compound engine a full set of four diagrams from each side was obtained at intervals of from two to three minutes. On the test of May 3, 54 full sets were obtained from the right-hand cylinder, and 47 full sets from the left-hand cylinder, running from Philadelphia to Washington; while on the return trip 50 sets were obtained from the right-hand cylinder and 45 from the left-hand cylinder.

The diagrams could be taken with greater rapidity from the standard engine, there being only one indicator to operate on each side; but an endeavor was made to keep the interval between the time of taking diagrams as nearly as possible 2½ minutes, so as to correspond with the other test. On the run of May 8, with the standard engine, 54 sets of diagrams were taken from each cylinder on the down trip and 53 sets on the return trip. On this engine the diagrams were taken, as a rule, simultaneously, the two operators communicating with each other by signal. On the compound engine, however, no attempt was made to take the diagrams from the two sides at the same time.

The close proximity of the indicators on the compound engine, on the first series of tests, enabled the four diagrams from the cylinders on one side to be taken at nearly the same time. On the second series, however, when the indicators were located at the two ends of the cylinders, several feet distant from each other, the diagrams from the two indicators were taken alternately.

MEASUREMENT OF SPEED.

On the first series of tests an observer in the cab counted the number of revolutions of the drivers per minute for 10 seconds to obtain the speed. The pull of a cord attached to the indicator rig enabled him to mark the completion of a revolution. The difficulty of accurately counting the revolutions at high speeds led to the use of a Shaeffer & Budenberger tacheometer attached to the side of the smoke-box and driven by a belt from the front driving wheel shaft through an intermediate countershaft placed under the boiler. This instrument worked very satisfactorily.

MEASUREMENT OF STEAM-PRESSURES, DRAUGHT, CUT-OFF, AND SMOKE-BOX TEMPERATURE.

The same observer who took the speed and time made a note immediately afterwards of the boiler pressure, the pressure in the right-hand steam-pipe, the amount of suction produced by the draught in the smoke-box, the position of the reversing lever, and, on the first series of tests, the temperature of the gases in the smoke-box. For this purpose pressure-gauges were attached, respectively, to the boiler at the front end, and to the right-hand steam passage at the entrance to the valve-chamber, and located on the inside wall of the inclosure, at points where they could be conveniently observed. These gauges were verified by comparison with a test-gauge during the progress of the tests. The gauge for determining the draught was a plain U-tube made of glass, one end of which was connected to the smoke-box. It was half filled with water, and the two arms were graduated to quarter inches. The position of the reversing lever was indicated by a rod attached to the lever, and extending forward to a scale at the front end of the boiler, which was graduated to correspond with the different notches on the quadrant. No observations were taken of the exact position of the throttle-valve. The pyrometer in the smoke-box was a metallic one, the stem of which was 2 ft. long. It was inserted horizontally about 2 ft. in front of the tube sheet placed at a central point. This instrument was not used on the second tests.

All these instruments were located in such a position that the observer who read them could do so without moving from his seat in the inclosure areund the pilot.

MEASUREMENT OF DRYNESS OF STEAM.

The writer's "Universal Calorimeter" [decribed in ENGINEERING NEWS, May 31, 1890], was employed for determining the dryness of the steam of each of the engines. It was attached to the right-hand passage leading to the cylinder, at a point in the saddle casting just below the smoke-box. The pipe for the attachment of the instrument extended into the passage, and the inclosed part was perforated with ⅛-in. holes. That part of the calorimeter called the "heat-gauge" only was used, the drip-box being dispensed with. The readings were confined to the thermometer which gives the temperature of the steam below the discharge orifice. The length of pipe connecting the instrument to the engine was 30 ins. for the compound and 36 ins. for the standard engine. The instrument was employed during the test of May 3 on the compound engine and that of May 8 on the standard engine, and it was also used on the express run of June 2. It was not employed regularly on the remaining tests.

CAB OBSERVATIONS.

A ¾-in. vent-pipe was attached as a branch to the blower-pipe in the cab, and used, during the tests, for relieving the pressure and for preventing the opening of the safety-valve during the scheduled runs. An assistant in the cab had charge of this vent, and opened it whenever the pressure rose to a blow-off point. This assistant kept a record of the time when this vent was in use. The same assistant took note of the time that the blower was in use, and, on the tests following May 6, the time that the fire-door was opened for the purpose of checking the fires. During the tests of the second series he also noted the number of times that the whistle was blown. All the cab records were omitted on the accommodation runs of May 27 and 28.

INCIDENTAL MEASUREMENTS.

At the end of the trip each way, as a rule, the quantity of ashes which was withdrawn from the ash-pan after cleaning the fires was determined by weighing.

On one occasion for each engine the cinders that were blown out from the smoke-box were collected and weighed. This was done for the compound engine on May 2 at Washington, and the quantity collected amounted to 576 lbs. The cinders were on this occasion nearly dry. They were weighed for the standard engine on May 8, and the quantity collected amounted to 803 lbs. These were somewhat wet from contact with the water used in blowing them out, and the weight given includes the moisture.

The quantity of steam discharged from the vent-pipe in the cab was determined by allowing the steam to blow from the vent for a certain time, and observing the fall of water in the gauge-glass on the boiler, and computing the quantity from the volume occupied in the boiler. The pipe was ¾-in. diameter, with a length of about 4½ ft. It contained one globe valve and one angle valve, and there was one right-angle bend. The amount discharged was at the rate of 22 lbs. per minute. The quantity of steam used by the blower was not tested. The blower-pipe, which was also of the ¾-in. size, had the same number and kind of valves, and the number of right-angle bends was two. The length of the pipe was 21 ft. Making an allowance for the greater friction in the discharge of the steam from this pipe, the quantity would probably be about 18 lbs. per minute.

The quantity of steam used by the air-pump for the brake system was determined by water-glass measurement, at a time when the engine was attached to a train of five cars, the train being at rest. The number of single strokes made per minute was 58, and the air pressure 86 lbs. per sq. in. Under these conditions, the pump used at the rate of 258 lbs. of steam per hour, of which a small quantity, say one-quarter, may be charged to leakage of the throttle-valve. This test was made on the compound engine. At times when the brakes are applied the pump makes from 150 to 200 single strokes per minute, for a period of about half a minute, the speed afterwards gradually falling to a normal, varying from 50 to 75 single strokes per minute, which it reaches at the expiration of from two to three minutes. For a three hours' trip, such as was made from Philadelphia to Washington, the quantity of steam used for the full time would probably be about 800 lbs.

The quantity of water used for blowing out the cinders at each end of a trip amounted to about 1 in., as measured in the tank. It was on one occasion 2 ins.

The area of the opening through which the steam passed out of the whistle was about 0.96 sq. in. The quantity of steam used for the whistle was not determined by test, but it may be roughly estimated. Assuming a pressure of 150 lbs., and assuming that the opening is an orifice in a thin plate, which for practical purposes is true, the quantity discharged would be at the rate of 2.2 lbs. per second. Assuming that the single short blast occupied one-quarter of a second, the two short blasts one-half of a second, the long blasts two seconds, the two long and two short blasts three-quarters of a second, each of these blasts in the order named consumed respectively 0.55 lb., 1.1 lbs., 4.4 lbs., and 1.6 lbs. of steam. With these assumptions, the total quantity of steam used on June 2, from Baltimore to Philadelphia, amounted to 425 lbs.

On the basis of these various measurements, it is believed that the steam used for the vent-pipe, the blower-pipe, the air-pump, and the whistle amounted to not over two per cent. of the total quantity of steam which was generated.

LEAKAGE TESTS OF VALVES AND PISTONS.

The condition of the cylinders of each engine, in the matter of tightness of valves and pistons, was tried with the engines in a state of rest under steam of full boiler pressure. When the valves of the compound engine were placed in a central position, and the throttle opened, there was no escape of steam from the cylinder-cocks of the low-pressure cylinder, which indicated that the valves of the high-pressure cylinder were tight. When the valves were thrown over, so as to allow the high-pressure cylinder to take steam, the reducing valves being shut, steam found its way out of the drain-cock at the opposite end of the low-pressure cylinder. This indicated either that the piston of the high-pressure cylinder leaked, or that the reducing valves leaked. This leakage occurred on both cylinders, but it was worst on the left-hand cylinder. The reducing valves on the first series of tests were common plug-cocks, and an examination of these showed that the plugs were loose; but it may be said that when these were screwed up the leakage appeared to be about the same. On the second series of tests these cocks were replaced by disk-valves. This did not appear to produce much change in the matter of leakage. When steam was admitted to the piston of the low-pressure cylinder there was no escape of steam from the drain-cock at the opposite end of either cylinder, showing that the pistons of the low-pressure cylinders were tight.

The valves of the standard engine when placed in their middle position were found to be tight. The pistons were also found to be tight when the valves were thrown over so as to give the engine steam, no steam at such times appearing at the smoke-stack.

In this connection it may be said that during the first series of tests, and during the tests of May 27 and 28, the high-pressure piston-rods of the compound engine, which were packed with metallic packings, caused some annoyance and loss by leakage. This was overcome, however, on the test of June 2. On the test of May 27, and on that of May 28, on the down trip, there was considerable leakage of the joint in the cover of the left-hand valve chamber.

GENERAL RESULTS OF THE TESTS.

On the first series of tests the relative coal and water consumption of the compound and standard engines was as follows:

Pounds coal consumed per round trip.	Maximum.	Minimum.	Average.
Standard	17,077	15,875	16,389
Compound	14,171	13,484	13,942
Difference	2,906	2,391	2,447
Ins. water per schedule run.			
Standard	130.4	122.6	126.4
Compound	125.1	121.5	122.5
Difference	5.3	1.1	3.9

It thus appears that the compound engine consumed on the average 14.9% less coal and 3.2% less water than the standard engine.

On the second series of tests (where the compound engine alone was tested), the interesting contrast is in the consumption of water and fuel on the accommodation runs and on the express runs over the same track, which was as follows:

Pounds coal used.	Maximum.	Minimum.	Average.
Accommodation run.	4,904	4,631	4,793
Express run	5,914	5,034	5,591
Ins. water used.			
Accommodation run.	48.4	47.1	47.8
Express run	49.3	43.1	47.1

The cab observations showed that the compound engine steamed much more freely than the standard engine. The vent pipe was held open on the compound engine from 13.5 to 20 minutes. On the standard engine it was opened only 13 minutes. On the compound engine the blower was used only 1 to 3½ minutes, while the standard engine used it for 8 to 20 minutes during the trip. The fire-door was open on the compound engine about a quarter of the time while running, while on the standard engine it was open only from 4 to 16 minutes.

The average results of the various tests as regards fuel and water consumption are given in Table V. [published last week.] The measurements on the compound engine showed that 10.1 per cent. of the water used was consumed at terminal stations. Assuming that an equal proportion of the coal burned was used at the terminal stations, this leaves 12,535 lbs. as the coal consumed on the road. The length of time the throttle valve was open was about 4.8 hours, and assuming that the fire burned only when the throttle was opened, this would give a consumption per hour of 2,612 lbs., or 103.7 lbs. per sq. ft. of grate surface. The average indicated horse power developed was 638.5, therefore this consumption of coal would be at the rate of 4.1 lbs. per I. HP. per hour.

It will be seen by the table that the compound locomotive evaporated considerably more water per pound of coal than the standard engine. This difference in boiler performance accounts for a large part of the superiority of the compound engine. In the tests of the compound engine alone a noticeable fact is that the average evaporation was much higher for the accommodation runs than for the express runs, being 7.38 lbs. of water per lb. of coal for the former and 5.96 lbs. for the latter. Computing by the same method that was used above, the rate of combustion of the compound locomotive for the 2.32 hour run with the accommodation train, on June 2, and we have 1,735 lbs. per hour, or 69 lbs. per sq. ft. of grate as the average rated combustion. The average indicated horse power on this run was 589.6. From this we deduce the average fuel consumption as 2.9 lbs. per I. HP. per hour. The improved evaporative performance on this test seems to have been due, in a measure at least, to the reduced rate of combustion. It is to be borne in mind, also, that the express runs were made with coal taken on at Baltimore, having a calorific value of 13,825 H. U. per lb., while the accommodation runs were made with coal taken on at Philadelphia, having only 12,684 H. U. per lb. Thus, on the basis of equal heat units, the performance on the accommodation run would be still better than that on the express run.

ANALYSIS OF CYLINDER PERFORMANCE.

In table *A* is given the performance of the cylinders, apart from the boiler, during selected periods of the tests. The quantities of power given are the average for the period taken. It will be seen that the water consumed per I. HP. per hour was 25.37 lbs. in the compound against 26.86 lbs. in the standard engine. This is a saving of only 5.5% in favor of the compound, and it will be remembered that the saving in water used was only 3.2%, whereas the saving in the consumption of coal, as already noted, was 14.9%. As the boilers of the two engines were exact duplicates of each other, this difference can hardly be explained by the supposition that the boiler of the standard engine was less efficient than that of the compound.

Likewise, also, the smoke passages and exhaust nozzles are duplicated in the two engines. There is, however, a difference in the action of the blast upon the fires in the two engines. The standard engine discharges its steam at a higher release pressure than the compound, viz., 21.2 lbs. per sq. in. against 16 lbs. in the compound, in. It may be presumed that this high release pressure produces more disturbance of the fire than occurs with the compound engine. This supposition is corroborated by the draught gauge readings, which averaged 3.7 ins. for the compound engine on May 3 and 4 ins. for the standard engine on May 8. This increased draught breaks up the bed of coal on the grate and causes a larger loss in the small unburned pieces of coal carried through the tubes. The direct examination of the fire showed that the compound exhaust disturbed the fire much less than the exhaust from the standard engine.

The economy of fuel secured by the compound, therefore, is due in some measure to the smaller amount of steam used to generate a given power, but more largely to the saving of fuel carried through the tubes by the severe and cutting blast of the standard engine.

In the second series of tests, the noticeable feature is the very low consumption of water per I. HP. by the compound engine on the accommodation run, viz., 20.86 lbs. This is about 19 per cent. less than the corresponding quantity used by the same engine on the express run of June 2. This improvement is due to the fact that the steam was distributed to the cylinders without the throttling which occurred at higher speeds.

The effect of reduced pressure and a longer cut-off in increasing the quantity of water used will be noticed in comparing the express runs on May 28 and June 2. The higher boiler pressure on the latter date was obtained by the use of a smaller exhaust nozzle, 3¼ ins. in place of the 3½ ins. used on May 28. This increased the draught from 3.9 ins. to 4.8 ins.

In this connection reference may be made to the fact that on the first series of tests the 3½-in. nozzles on the compound locomotive were too small, causing the engine to make steam faster than it was used, while the same size nozzle on the standard engine making the same run was not small enough to keep up the steam pressure.

ANALYSIS OF DIAGRAMS.

Full measurements of selected average diagrams on some of the tests, and the deductions which are drawn therefrom, giving the quantities of steam accounted for by the indicator at various points in the diagrams, are given in table B.

Making a comparison between the record of the cards for the tests of May 3 and 8, the first thing which is noticeable is the difference in the initial pressure in the high-pressure cylinder of the compound engine and that shown in the cylinders of the standard engine. A second noteworthy difference is seen in the proportion of the

A.—PERFORMANCE OF CYLINDERS IN RESPECT TO WATER CONSUMPTION AND INDICATED HORSE-POWER.

Name and Number of Engine.	Compound.	Standard.	Compound.		
Date of Test	May 3.	May 8.	May 28.	June 2.	June 2.
Class of Train	Lim. Express.	Lim. Express.	Express.	Accommodation.	Express.
Length of time throttle was open (hours)	6.53	6.85	1.76	2.228	1.792
Total water consumed (lbs.)	105,834.	120,590.	29,326.	27,404.	28,706.*
Water consumed per hour (lbs.)	16,199.9	17,606.9	16,662.5	12,299.8	16,019.5
Ave. speed in revs. per minute (revs.)	269.5	284.3	255.9	176.2	256.8
Ave. speed, miles per hour (miles)	52.9	55.8	50.2	34.6	50.4
Average M. E. P., H.-P. Cyl., right (lbs.)	46.09	35.49	43.79	53.98	40.
" " L.-P. Cyl., " (lbs.)	17.49	.....	17.02	25.91	18.98
" " H.-P. Cyl., left (lbs.)	33.49	31.90	37.57	58.14	41.02
" " L.-P. Cyl., " (lbs.)	17.30	.....	17.73	22.22	16.54
Indicated HP., H.-P. Cyl., right (I. H. P.)	162.4	342.1	148.2	190.6	138.0
" " L.-P. Cyl., " (I. H. P.)	176.9	.....	163.1	172.2	184.4
" " H.-P. Cyl., left (I. H. P.)	122.8	313.4	130.7	138.6	141.3
" " L.-P. Cyl., " (I. H. P.)	176.4	.....	170.2	148.2	159.8
" " whole engine (I. H. P.)	638.5†	655.5†	612.2	589.6	623.5
Average boiler pressure (lbs.)	148.2	129.6	132.9	142.	151.6
Ave. pressure in right-hand steam pipe (lbs.)	141.9	115.3	122.4	136.6	140.2
Average indication of draft gauge (ins.)	3.8	4.1	3.9	3.8	4.8
Ave. position of reversing lever, No. of notch	10 5	10.9	9.3	9.9	10.4
Water consumed per I. H. P. per hour (lbs.)	25.37	26.86	27.22	20.86	25.60*

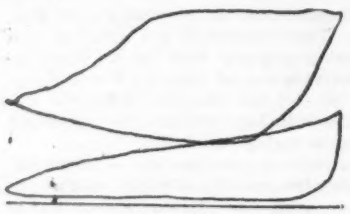
*Corrected for steam used during the stop at Foy's Hill.
†The maximum power developed at any one time in the case of both engines was 866 HP.

B.—FULL MEASUREMENTS OF SELECTED DIAGRAMS AND STEAM ACCOUNTED FOR BY INDICATOR.

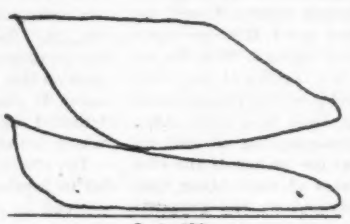
Date when diagrams were taken....1890	A. May 3.		B. May 8.		Express. May 28.		Accommodation June 2.	
Engine	Compound.		Standard.		Compound.			
Which cylinder	Right.	Left.	Average of both.		Right.	Left.	Right.	Left.
Number of diagrams figured	4	3	3	1	2	2	2	2
Pressure in R.-H. steam-pipe, above atmosphere (lbs.)	145	145	113	122	125	128	130	134
Pressure above atmosphere at highest point on steam line, H.-P. cyl. (lbs.)	142.6	138.9	97.7	103.7	118.6	115.7	139	132.7
Pressure above zero:								
At cut-off, H.-P. Cyl. (lbs.)	125.2	112.7	71.2	73.2	114.4	114.3	137 2	129.6
At release, H.-P. Cyl. (lbs.)	81.8	71.4	35	39.4	83.9	82.6	89.8	81.8
At selected point after cut-off, L.-P. Cyl. (lbs.)	34.2	34.3	.....	.....	36.2	36	41.4	30.2
At compression, H.-P. Cyl. (lbs.)	104.2	101.2	41.4	34.8	86.9	96.6	93.9	80.1
At compression, L. P. Cyl. (lbs.)	32.5	28.4	.....	.....	34.4	30.6	24.9	20.8
Pressure above atmosphere at lowest point on exhaust line, L.-P. Cyl. (lbs.)	6.9	4.8	5.7	5.3	9	6.4	6.6	2.8
M. E. P., H.-P. Cyl. (lbs.)	43.21	32.48	29.76	34.46	47.94	41.5	57.07	58.85
M. E. P., L. P. Cyl (lbs.)	15.85	16.17	.....	.....	18.32	20.1	27.61	21 94
Ave. revs. per minute (revs.)	282	270	290	276	256	240	167	171
Speed in miles per hour (miles)	55.5	53	57	54.1	50.2	47.1	32.8	33.6
Proportion of stroke completed:								
At cut-off, H.-P. Cyl	0.582	0 511	0.373	0 415	0.707	0.602	0.64	0.6
At release, H.-P. Cyl	1	1	0.81	0.78	0.99	0.99	0.99	0.98
At selected point after cut-off, L.-P. Cyl	0.8	0.704	.....	.....	0.84	0.826	0.79	0 83
At compression (backward stroke), H.-P. Cyl	0.136	0.157	0.175	0.227	0.1	0.105	0.14	0.14
At compression (backward stroke), L.-P. Cyl	0.179	0.22	.....	.....	0.13	0.146	0.17	0.19
Steam accounted for by indicator:								
Cut-off, H.-P. Cyl. (lbs.)	21 81	17.26	23.42	23.62	23.96	21.85	18.33	19.69
At release, H.-P. Cyl. (lbs.)	24.01	21.86	23.4	22.6	23.96	22.98	17.87	18.92
At selected point after cut-off, L.-P. Cyl. (lbs.)	23.51	22.61	.....	.....	24.77	24.81	17.6	21.25
Feed-water consumed per HP. hour (lbs.)	25.37		26 86		27.22		20.86	
Ave. proportion feed-water accounted for at cut-off, H.-P. Cyl	0.77		0.88*		0.84		0.91	
Ditto at release, H.-P. Cyl	0.9		0.84*		0.86		0.88	
Ditto at selected point, L.-P. Cyl	0.91		.....		0.91		0.93	

*Compared with B.

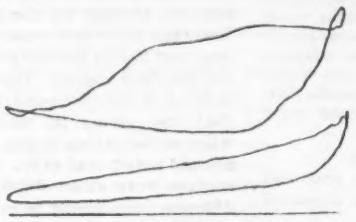
stroke completed at cut-off on the high-pressure cylinder of the compound engine as compared with that of the standard engine. Whether the standard engine would have shown a better performance with a higher initial pressure, or whether the compound engine would have shown a different performance with a different adjustment of the point of cut-off, and, furthermore, whether the conditions in general, which control the performance of the individual engines, were such as to secure a fair comparison between the two, are matters of conjecture upon which the data of the tests throw little light, and it is needless perhaps to discuss the effect which changes of condition might have had. In this comparison, however, of the results of the computations of steam accounted for by the diagrams, the fact stands out very plainly that at the point where the steam is about to be released from the cylinders the quantity of steam consumed by the engine, figured from the diagram, is about the same in one engine as in the other; and under these circumstances the quantity of steam actually consumed could not be expected to differ much in one case from that in the other.



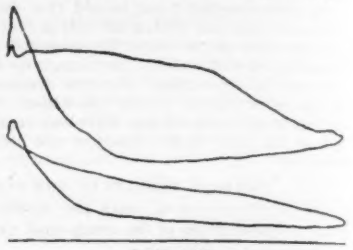
Scale, 120.
Right-Hand Cylinder; Crank End.
24.7 miles per hour.
Time, 7:04 A. M. Revs. per min., 125. Boiler pressure, 142 lbs. Steam pipe pressure, 139 lbs. No. of notch, 10. M. E. P., H.-P. Cyl., 58.1 lbs. L.-P. Cyl., 33-4 lbs.



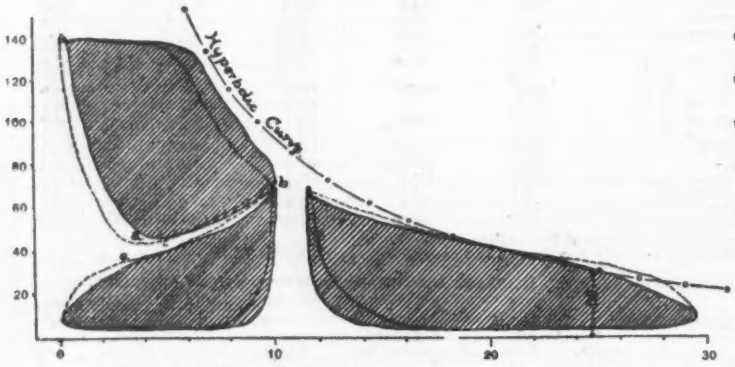
Scale, 120.
Right-Hand Cylinder; Front End.
23.6 miles per hour.
Time, 7:06 A. M. Revs. per min., 120. Boiler pressure, 142 lbs. Steam pipe pressure, 139 lbs. No. of notch, 10. M. E. P., H.-P. Cyl., 58.1 lbs. L.-P. Cyl., 32.6.



Scale, 120.
Right-Hand Cylinder; Crank End.
59 miles per hour.
Time, 4.51 1-2 P. M. Revs. per min., 300. Boiler pressure, 152 lbs. Steam pipe pressure, 142 lbs. No. of notch, 10. M. E. P., H.-P. Cyl., 39.1 lbs. L.-P. Cyl., 19.6 lbs.



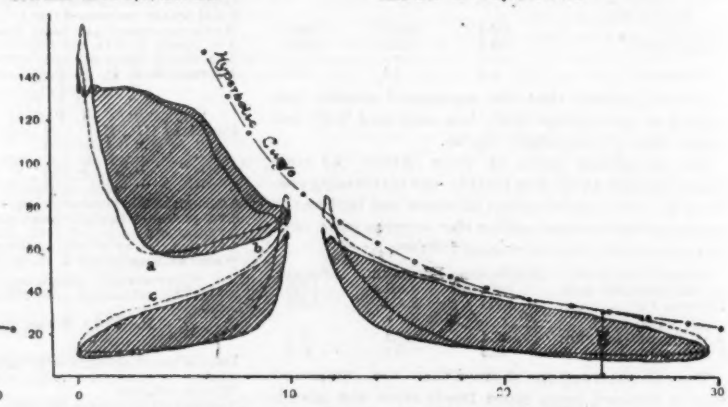
Scale, 120.
Right-Hand Cylinder; Front End.
54.1 miles per hour.
Time, 4:50 1-2 P. M. Revs. per min., 275. Boiler pressure, 153 lbs. Steam pipe pressure, 143 lbs. No. of notch, 10. M. E. P., H. P. Cyl., 42.3 lbs. L.-P. Cyl., 18.3 lbs.



Combined Diagrams, Based on the Above, at Slow Speed.

Full line, H.-P., Front End. L.-P., Crank End. Dotted Line, H.-P., Crank End. L.-P., Front End. Clearance, H.-P. Cyl., 12 per cent. L.-P. Cyl., 8 per cent.

INDICATOR DIAGRAMS FROM COMPOUND LOCOMOTIVE AT SLOW SPEEDS. TEST OF JUNE 2.

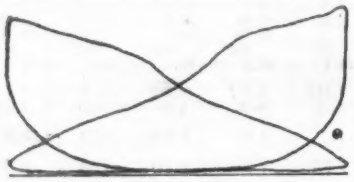


Combined Diagrams, Based on the Above, at Fast Speed.

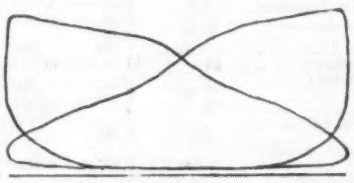
Full Line, H.-P., Front End. L.-P., Crank End. Dotted Line, H.-P., Crank End. L.-P., Front End. Clearance, H. P., Cyl., 12 per cent. L.-P. Cyl., 8 per cent.

INDICATOR DIAGRAMS FROM COMPOUND LOCOMOTIVE AT FAST SPEEDS. TEST OF JUNE 2. (Second Series.)

In the combined diagrams above, the lower left-hand diagram represents the work done in a low-pressure cylinder of the same area as the high-pressure cylinder; the lower right-hand diagram represents the work done in a low-pressure cylinder 1.8 times the area of the high-pressure cylinder. Therefore, as the ratio between the areas of the two cylinders of the engines was 2-8 to 1, the two diagrams together make up the total for the low-pressure cylinder on the same scale of volume as the high-pressure diagram. The space between the right-hand and left-hand diagrams represents that portion of the clearance space not covered by the clearance laid down in the left.



Scale, 120.
Right-Hand Cylinder.
23.6 miles per hour.
Time, 5:50 A. M. Revs. per min., 120. Boiler pressure, 127.5. Steam pipe pressure, 117 lbs. No. of notch, 11. Av. M. E. P., 55.1 lbs.



Scale, 120.
Right-Hand Cylinder.
25.91 miles per hour.
Time, 10:27 1-2 A. M. Revs. per min., 132. Boiler pressure, 138.5 lbs. Steam pipe pressure, 132 lbs. No. of notch, 10. Av. M. E. P., 66.3 lbs.

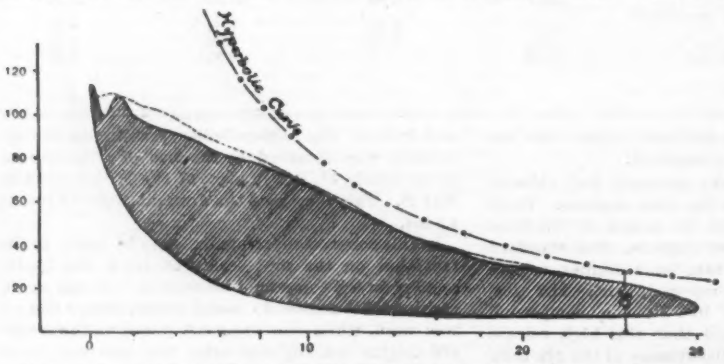


Diagram from Standard Engine, on Same Scale as Combined Diagrams Given for Compound Engine.

R.-H. Cylinder, May 8, 1890. 56.55 miles per hour.
Steam pipe pressure, 123 lbs. Revs. 268. Av. M. E. P., 37.3 lbs. Full line, front end. Dotted line, crank end. Clearance, 9 per cent.

INDICATOR DIAGRAMS FROM STANDARD ENGINE. TEST OF MAY 8.

The analysis of diagrams for the accommodation trip of June 2, in which the conditions are different from those in the other tests only in the matter of speed, shows, in a measure, the reasons for the improved performance of the compound engine under these favorable conditions. With about the same release pressure in both cases, a much larger amount of work is done in the case of the diagrams taken at slow speed than in the other case. The mean effective pressure measured from diagrams on the accommodation run, is about 58 lbs. per sq. in. for the high-pressure cylinder, and about 24 lbs. for the low-pressure cylinder; while on the express run the mean effective pressure is about 44 lbs. for the high-pressure cylinder and about 19 lbs. for the low-pressure cylinder.

The effect which a gradual increase of speed has upon the economy with which the steam is distributed is shown by additional diagrams, taken June 2, which have been worked up in full. The average of several sets, taken at a speed of about 140 revs. per minute (27.5 miles per hour), showed 17.5 lbs., 17.2 lbs., and 19.3 lbs per HP. per hour, at the high-pressure cut-off, high-pressure release, and low-pressure release, respectively. The average of several sets, taken at a speed of 200 revs. per minute (39.3 miles per hour), showed 19.2 lbs., 19.4 lbs., and 21.2 lbs., respectively. The average of still another set, taken at 290 revs. per minute (55 miles per hour) showed 22.5 lbs., 25.3 lbs., and 24.5 lbs., respectively. The loss produced by the increase of speed is due to the wire drawing of the steam in its passage from the high-pressure cylinder, through the valve, and through the low-pressure cylinder. It appears to the writer that improvements can be made in the size and arrangement of the passages, which will secure better performance, and that such improvements should be undertaken.

In the matter of the admission of steam to the high-pressure cylinder, the operation of the engine is all that could be desired, nearly the full boiler pressure being maintained during the greater part of the period of admission. This cannot be said of the diagrams from the standard engine, which, at ordinary speeds, show a large amount of wire-drawing. The loss produced by wire-drawing of the steam in its passage into and through the low-pressure cylinder of the compound engine is well exhibited to the eye by the combined diagrams, given herewith. These diagrams are laid out from the original diagrams, given above them. One is a set of diagrams taken at slow speed, and one a set taken at medium fast speed. The actual loss of pressure which the steam sustains in passing from one cylinder to the other is shown by the area unshaded, or *a*, *b*, *c*, which lies between the two diagrams on the left. The remaining losses of pressure are shown by the balance of the unshaded areas enclosed between the clearance line, the atmospheric line, and the line of hyperbolic expansion. These diagrams are followed by one on the same scale, taken from the right-hand cylinder of the standard engine.

Copies of the diagrams taken from the standard engine are given to correspond with those taken at slow speed on the compound engine. One of these is taken at 132 revs. per minute (29 miles per hour), with cut-off 0.49 pressure in the steam-pipe 132.5 lbs., and this shows a consumption by diagram of 23.5 lbs. at cut-off, and 23.0 lbs. at release. The other is taken at 120 revs. per minute (23.6 miles per hour), with a cut-off of 0.41, and a steam-pipe pressure of 114 lbs., and this shows for steam accounted for a consumption of 21.5 lbs. at cut-off, and 21.2 lbs. at release. The average of four full sets of diagrams at slow speeds gives the following results: Boiler pressure, 132 lbs.; steam-pipe pressure, 118.5 lbs.; cut-off, 0.41; M. E. P., 54 lbs.; revs. per minute, 141 (miles per hour, 27.7); steam accounted for at cut-off, 21.7 lbs. and at release, 21.5 lbs. Turning to the figures given in the table, the sample diagrams taken at a mean speed of 283 revs. per minute (55.5 miles per hour) show at cut-off a mean of 23.5 lbs., and at release a mean of 23 lbs.

From a comparison of these quantities, a fair idea may be gained of what the actual feed-water consumption of the standard engine is at slow speeds. The diagrams show a reduction at the slow speed of 23.5 lbs.—21.7 lbs. = 1.8 lbs. below that at fast speed. This reduction

amounts to 7.7%. The corresponding reduction in the quantity of feed-water used may be assumed, for practical purposes, to be the same. Using the quantity of feed-water obtained on the fast-speed test, given in table B—viz., 26.86 lbs.—the estimated consumption for a slow speed of 141 revs. per minute (27.7 miles per hour) becomes $26.86 \times .077 = 2.07$ lbs. less than that quantity, or 26.86 lbs. — 2.07 lbs. = 24.79 lbs. per HP. per hour. Comparing this result with the consumption of water obtained on the slow-speed test of the compound engine, which was 20.86 lbs., it appears that the compound engine uses 24.79 lbs. — 20.86 lbs. = 3.93 lbs., or 16% less steam at slow speed than the quantity estimated for the standard engine at slow speed.

For the same reason that the saving of fuel was found to be greater at the fast speed than the saving of steam, it may be expected that the fuel saving would also be the greater at slow speed. There is even more reason for a greater fuel saving in the case of the slow speed, when it is considered that the release pressure and the tendency of the blast to tear the fire is greatly augmented in the standard engine as the speed is reduced, while there is very little change in the compound engine. In the diagrams from the standard engine, referred to here, the mean release pressure at the high speed is 22.5 lbs., and at the slow speed 36.8 lbs. above the atmosphere, while the compound engine diagrams show precisely the same release pressure at both speeds. It is not easy to predict what effect this disturbing element in the combustion of the fuel has upon the problem, but the differences in the exhaust blast are such that it would be surprising if the loss from extra fire disturbance in the standard engine were not twice as great at the slow speed, as it was shown to be on the test at the fast speed. If such is the case, the consumption of fuel in the compound engine at the slow speed would be about 35% less than that in the standard engine. It will certainly not be overestimating the case if the expected saving of the compound engine at slow speeds is placed at 30% of the coal.

In analyzing the computations based on the diagrams from the compound engine, it would appear, when confining attention to the cut-off of the high-pressure cylinder, that the saving of steam produced by this engine is due to the more economical distribution of the steam which is afforded by the compound principle. The quantity of steam accounted for at cut-off shows, in every case, a much smaller figure than the actual water consumption. If, however, attention is confined to the steam accounted for at release of the low-pressure cylinder, it would appear that the saving of steam in the compound engine is due to the reduced amount of cylinder condensation secured, on account of the expansion being effected in two cylinders instead of one. There is in every case whether at low or high speed, an increase in the quantity of steam shown in the low-pressure cylinder at release over that shown in the high-pressure cylinder at cut-off. This is the same effect that would be produced by leakage of steam from the high-pressure cylinder into the low; and this difference is so marked that there is a suspicion that such leakage existed. It may be held that the difference referred to was produced by evaporation of water, which was condensed in the high-pressure cylinder. It does not seem reasonable, however, that the condensation in the high-pressure cylinder should be so large as that in the cylinder of the standard engine, and here the quantity accounted for was 0.86 as against 0.77 in the high-pressure cylinder of the compound engine. These questions, as to the causes which led to economy, are easy to discuss, but difficult to settle.

It is to be noted that in all the results figured from the diagrams the quantity of steam accounted for at the release of the high pressure cylinder, where the high speed prevails, is greater by a considerable amount than that accounted for at the cut-off in the same cylinder. An examination of the diagrams will show that the pressure at a point near the end of the stroke rapidly increases, and that at a point on the compression line there is a disturbance in the form of the curve. The negative lap on the exhaust edge of the valve which controls the high pressure cylinder provides a communication between the expanded steam at one end and the compressed steam at the other, by which some of the compressed steam is discharged backward into the other end of the cylinder before the release. The quantity of steam present in the cylinder at the end of the stroke is, therefore, increased beyond that which comes from the legitimately expanded steam. The writer attributes the increase in the steam accounted for at this point to the disturbance which is thus produced. The actual quantities are, doubtless, in reality less than the figures given.

MISCELLANEOUS RESULTS.

The normal indication of the calorimeter, when the engine was at rest, and steam of 117 lbs. pressure at the steam pipe was allowed to stand upon the instrument, was 269°. It is assumed that the normal at a pressure corresponding to the average of 142.8 lbs. for May 3 is 280°, and the normal for a pressure of 114 lbs. is 267°. This last is taken at 262° for the standard engine on account of the longer connections. With these normal figures the cooling produced by the moisture in the steam on the compound engine was 5°, and on the standard engine 7°. The cooling effect produced by 1% of moisture for this instrument is 20°. The quantity of moisture, therefore, in the steam tested was, for the compound engine 5-20 or 0.25 of one per cent., and that for the standard engine 7-20 or 0.35 of one per cent. These percentages are noticeably small, and they furnish satisfactory indications that the steam of both engines entered the cylinder in nearly a dry state. The instrument from time to time showed slight variations, but these appeared to be produced by variations in the pressure, rather than by variations in the condition of the steam.

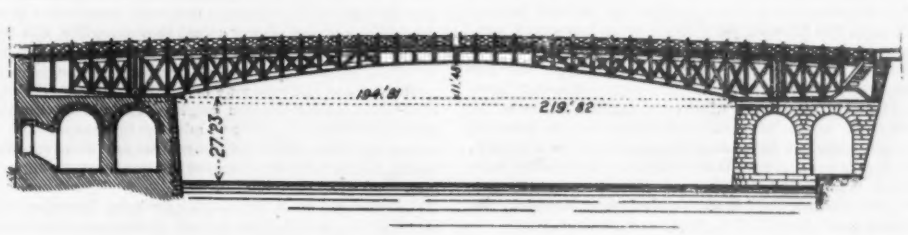
The indications of the pyrometer are believed to be unreliable. Very little change was produced in the instrument by variations in the work of the engine, after once starting. When the pyrometer was tested, in comparison with two high-grade thermometers, one at each end of the stem, both being immersed in a current of superheated steam, the thermometers indicated an average of 70° less than the pyrometer when this indicated 600°. The introduction of a high-grade thermometer in the opening provided for the pyrometer, on the accommodation run of May 28, showed that the temperature was beyond the range of the thermometer, which was graduated to 620°. The fact that on tests of other locomotives which the writer has made, the pyrometer varied from 600° to 800°, according to the conditions of the work, convinces him that the pyrometer was not sufficiently sensitive to show reliable indications.

The maximum draught taken during the whole series of tests was 7.5 ins., and this occurred on the express run of June 2, when the size of the nozzle in use was 3¼ ins.

The Tarento Drawbridge.

We give a cut herewith of the largest drawbridge in Italy. It is on the highway between Tarento and the mainland, near Lecce, in southern Italy, and is one of the greatest achievements of engineering skill in that country. As may be seen from the cut, for which we are indebted to the *Schweizerische Bauzeitung*, there are two movable arms, instead of the more usual central pier and single draw. The latter construction was impossible on account of the injury the pier would do to navigation in and out of the harbor formed by the island and the mainland.

The bridge has a clear span of 194.87 ft., a height at the abutments of 28.87 ft., and at the center, of 40.38 ft. above mean water. When it is closed, the upper and lower chords form arcs of circles of 3,245 ft. and 524.94 ft. radius, respectively. The arms are



DRAWBRIDGE AT TARENTO, ITALY.

supported by center posts and wheels in the usual way. The center post socket is 35.93 ft. from the end of the shore arm and 11.81 ft. from the face of the abutment. The arms are manœuvered by turbines placed directly below the center posts. The shafts of these motors are prolonged upward and connected by proper gearing to the wheels at the ends of the shore arms. When these wheels are set in motion the draw opens. Before this can be done, however, it is necessary to raise the center of the bridge in order that the interlocking apparatus, conical surfaces in the face of one arm fitting into corresponding recesses in the other, may be disengaged. It will be noticed in the cut that the bottom chords of the shore arms slope upward from the center posts, thus enabling a considerable vertical play to be given the structure. In order to unlock the draw, the shore arms are pulled down by means of shafts and gears moved by the turbines, and the center of the draw raised in this way about 32.5 in. The shore arms being weighted until they are heavier than the others, it is much easier to open than to shut the bridge, since in the first operation the heavier parts are lowered while in the second they are raised. The draw can be opened by the turbines in 7 minutes and closed in 10. In case the motors fail to work the arms can be opened and closed by workmen in about 15 and 21 minutes respectively.

There are four trusses in the structure, weighing together about 1,60 tons per ft. The roadway is nearly 22 ft. wide; the greatest live load is taken at 92 lbs. per sq. ft. A counterweight of 292.6 tons is placed on each shore arm.

The bridge proper cost 400,000 lire (about $100 000), and the turbines and machinery came to 45,000 lire (about $11,250) more. It was constructed under the direction of the Engineer in Chief A. COTTRAU by the Impresa Industriale Italiana per Costruzioni Metalliche, and was opened to the public in May, 1887.

The Keswick Water Power Electric Light Station.*

(WITH INSET.)

The Keswick Electric Light Station is the first attempt in England to utilize available water power for the purposes of a public supply of electric light.

Early in 1889 the directors of the Keswick Electric Light Co. instructed the authors to prepare plans and to procure tenders for the erection of a central supply station in or near Keswick. Several sites were offered, of which two had water power available, both being situated on the River Greta.

As the area proposed to be lighted was large and sparsely populated, and as many of the prospective consumers were gentlemen who houses were at some distance apart, it was seen that the only feasible system to adopt was an overhead high-tension one. The alternating current transformer system was finally selected. Whatever difference of opinion there may be as to the best system for lighting large towns, there seems to be no doubt that if at the present time any general scheme of lighting small towns and scattered suburbs with electricity is to be made a commercial success, a high-tension system, or some modification of it, must be adopted.

On account of the high price of coal at Keswick, it was considered desirable to use this water power as far as possible in preference to steam. The saving effected is considerable. The rent paid for the water power is 10s. ($2.43) per HP. per annum. Taking the number of HP. hours required per annum as 100,000 for the present output of the station from a 50-HP. turbine, the cost per HP. hour comes out as .06d. ($.0012). On the other hand, taking the price of steam coal at 15s. ($3.64) per ton and the quantity burned per HP. per hour as 6 lbs., the cost per HP. hour comes to 0.48d. ($.97), or eight times the cost of water power. In addition to this, the attendance required for a turbine is, of course, less than that necessary for a steam engine and boiler; the first cost, maintenance, and depreciation are also considerably less, and the chances of a breakdown much more unlikely. The authors accordingly decided to recommend the directors to obtain a site on the River Greta, about three-fourths of a mile from the town of Keswick, which had formerly been occupied by an old woollen mill, there being still in existence head and tail races, which, with repairs and some enlargement, could be made use of (Fig. 1). The head race is one fourth of a mile in length, the tail race about 100 yds. The old tail race extended down stream only some 70 yds., but by adding 30 yds. to its length and increasing the depth about 4 ft., an extra head was obtained, which increases the total head now available to 20 ft.

The bed of the tail race was rock, of which some 222 cu. yds. had to be removed in order to deepen it. The head race was repaired and deepened, the cross-section below the water-level being made 21 sq. ft., the dimensions being in most places 7 ft. wide by 3 ft. deep.

As there was a possibility of partial failure of the water supply during extreme drought in summer, it was decided to provide steam in addition to water power. Figs. 2 and 3 represent the general arrangement of the station. A 50-HP. turbine is built into the end wall of the head race, a portion of its casing and the wheel and guide vanes projecting into the race. Its speed is regulated by a hand

*A paper read by W. P. J. FAWCUS and E. W. COWAN before the Institution of Civil Engineers.

wheel in the station, which, by means of suitable shafts and gearing, opens and closes the guide passages. The turbine and draught tube are supported by the end wall of the head race and a cast-iron girder built into the retaining-walls of the tail race. Two similar girders carry the two pedestals of the main shaft, which latter can be put in or out of gear with the turbine by means of a claw clutch. The stand-by engine, a 50-HP. Westinghouse, is fed by steam from a 20 nominal HP. Hyde duplex vertical boiler placed in a separate boiler room. The engine is arranged to drive on to the main shaft (Fig. 3). The driven pulley on the main shaft can be put in or out of gear by means of a friction-clutch actuated by a hand-lever. This arrangement permits of the alternator and exciting machine being driven by either the turbine or the engine, or by both should the shortness of water render it necessary to supplement the power of the former.

Provision has been made for the addition of another turbine and two 30 kilowatt alternators, when the demand for the light requires it, involving only a slight enlargement of the building. The installation would then have a total capacity of 3,000 8-candle power glow lamps. The alternator at present erected is a Kapp 30-kilowatt machine.

It is intended to fix a fan in the boiler room to produce a forced draught, the power for driving it being obtained from the turbine. The belting, leather chain-link, is arched to suit the curvature of the pulleys. The switchboard and electrical instruments are fixed on the north wall of the station, near the regulating handle of the turbine. Additional regulation is obtained by varying the resistance in the exciting circuit, and so the magnetic field of the alternator.

THE TURBINE.

The turbine (Figs. 2 and 4) is of American design, and is called the "Victor." It is of a "mixed-flow" type, the wheel being 20 ins. in diameter. This turbine was selected as being the one which seemed best suited to the work to be done, for the following reasons: In the first place, its speed was 273 revs. per minute, which is at least 70 per cent. greater than the speed of an "inward," "outward," or "parallel flow" turbine would have been working under a similar head of only 20 ft. The alternator having to run at 750 revs. per minute, it was advisable that the speed of the turbine should be as high as possible to avoid the mechanical difficulties of speeding up. The regulation is effected by opening and closing a cylindrical sluice working between the guide passages and the wheel.

As the turbine was 16 ft. above the level of the tail race, a draught tube was necessary to give full effect to the head of 20 ft. This draught tube is of wrought iron 14 ft. long and 3 ft. in diameter. The maximum velocity of water flowing through it is a little over 4 ft. per second.

The speed obtained, when running the turbine light at full gate, was 345 revs. per minute, or an increase of only about 26 per cent. above the normal speed of 273 revs. per minute. The volume of water passing through the turbine when running light at full gate was about three-quarters of that flowing when carrying its full load, the additional speed of revolution retarding its passage. Though there can be no doubt that automatic regulation, sufficiently sensitive for the purposes of an electric light station, is difficult to obtain with water motors, nevertheless, for hand regulation, such as is used at Keswick, the method above described is simple and efficient.

THE ENGINE.

The engine is a Westinghouse of simple type, having two single-acting cylinders 10 ins. in diameter by 9 ins. stroke. It is fitted with a sensitive governor. A test of the brake HP. developed at 80 lbs. steam pressure gave 50.11 HP., the engine running at 350 revs. per minute. Upon taking the load off the brake and allowing the engine to run light, the speed increased to 360 revs. per minute, or less than 3 per cent.

This type of engine, on account of its compactness, is very suitable for providing reserve power. The floor space taken up by the above engine is 7 ft. by 4 ft.

THE BOILER.

The boiler is a 20 nominal HP. Hyde duplex, made by Messrs. Tinker, Shenton & Co. It is 4 ft. 6 ins. in diameter, and 11 ft. 6 ins. in height. The grate area is 13 sq. ft., and the heating surface 200 sq. ft. The heated gases pass twice diametrically across the boiler. The water evaporated per pound of coal is about 11 lbs. The working pressure is 120 lbs. to the square inch.

THE ALTERNATOR.

The alternator, Fig. 5, which was designed by Mr. Gisbert Kapp, and manufactured by Messrs. Johnson & Phillips, is a 30-kilowatt separately excited machine, giving an output of 15 amperes at 2,000 volts. Its speed is 750 revs. per minute, and the frequency 75.

The armature has a cast-iron supporting ring 28 ins. in diameter and 2¼ ins. wide, provided with six arms. The armature core is of charcoal iron strip, 2¼ ins. wide, with paper insulation, and wound to a radial depth of 8 ins. There are 19 coils, each containing 100 turns of 0.072-in. wire covered to 0.092 in. in two layers.

The resistance of the armature after working some hours was found to be 7 ohms. The magnetic field consists of 12 magnets on each side of the armature. The cores and pole-pieces are of wrought iron, the yoke rings of cast iron. The former are cylindrical, 3¾ ins. in diameter. The latter are 4 ins. by 7¼ ins. Each core is wound with six layers of 58 turns per layer with 0.102-in. wire covered to 0.117 in. The total resistance of the field after working some hours was 11.2 ohms. The curve (Fig. 6) shows the relation between the armature electromotive force and the exciting ampère turns.

When working with an output of 15 ampères, the machine gives 2,000 volts at its terminals with an exciting current of 9 amperes. Therefore the energy of the field is 900 watts, or 3 per cent. of the output. The framework is of substantial construction, and the machine when running is remarkably free from vibration.

Its open design admits of the ready passage of air to the armature, which will carry over 20 amperes without overheating. Should access to the armature be necessary, the field magnets can be racked aside in a short space of time. This provision has been found useful by the station attendant on at least one occasion.

The exciting dynamo is a small 1-kilowatt machine of the Gramme type, giving 10 ampères at 100 volts. The strength of the exciting current is varied for regulation purposes by altering the resistance in the field magnet circuit. A Cardew voltmeter shows the electromotive force of the secondary circuit, and an Evershed ammeter the high-tension current. A voltmeter and ammeter, placed on the switchboard in circuit with the exciting machine, are useful for indicating whether its brushes are working properly or need adjustment. The voltmeter in circuit with this machine also serves the purpose of a speed indicator for the turbine.

Two circuits leave the station, both of which are double pole, fused and provided with double pole switches and lightning arresters. The switchboard is in a glass case. A platform on oil insulators is arranged for the floor under the switchboard and alternator.

THE OVERHEAD MAINS.

There are some special features in the method of carrying out this part of the work to which the authors desire to invite attention. When the station was planned there was a good deal of uncertainty as to the amount of light which would be required in different localities; and the consumers being widely spread, it became necessary, both on this account and on account of the intention to place a portion of the mains underground when the supply became more certain, to run the overhead mains as economically as possible.

If wire of the highest insulation had been used the expenditure would have been considerable, and it does not appear that any great advantage, other than the increased durability of the mains, would have resulted. It was therefore determined to use a lower insulation for the mains, to rely upon the points of support for insulation, and to use special arrangements for cutting off all surface leakage where the wires enter the consumer's premises. The authors are not aware that attention has been paid to this point before; yet it would seem that in wet weather, upon a long line of overhead mains, however well insulated the wire may be, the surface leakage, when high-tension currents are employed, would be considerable; and if devices are not adopted for cutting this off where the wires enter buildings, leakage to earth must result, which may be a source of danger, as well as of loss.

The overhead mains at Keswick are being insulated from earth and from each other by oil throughout the system, Messrs. Johnson & Phillips' well-known oil insulators being used; and where the wires enter a building they are provided with surface-leakage arresters. These leading-in arrangements are illustrated by Fig. 7.

The leading-in wires, which are insulated with vulcanized indiarubber of the highest quality, are threaded through a shackle oil insulator, the wire being cemented in with Chatterton's compound. Such an arrangement should effectually cut off surface leakage from the mains. The leading-in wires enter the roof through a stone-ware pipe, provided with a covering piece to keep out rain and cover a reservoir of oil in the mouth of the pipe. A preliminary test, made on a very wet night, gave about 1 megohm as the total insulation-resistance of the mains. This is equivalent to about 3 megohms to the mile; but it should be pointed out, in connection with this result, that when the test was made the line work was not finished, and the leading-in arrangements were incomplete. The test was made with 100 volts.

The sizes of the mains are fixed for a current density of 500 amperes to the square inch. The fall of potential between the generating station and the town is only slightly above 1 per cent. at full load. The result, from using wires of ample size, is that the pressure is practically constant at all points of the distributing system under varying load.

The poles are of wood, and are placed about 202 ft. apart, varying in height from 22 to 28 ft. Steel suspension strand is used for supporting the mains for all the circuits, consisting of three strands, each strand being 14 B. W. G., and galvanized. The mains are suspended from it by stoneware suspenders of special design, one of which is illustrated by Fig. 7. These suspenders are very simple to attach; they are tied on to the cable at the right distances apart, and then hooked on to the suspension strand.

One short run of underground mains is being tried, the Brooks' fluid system being used. In this system the conductors are thickly covered with fibre, and are braided; they are carefully desiccated, and are then drawn into iron pipes, provided with suitable "draw-in" and "branch-circuit" boxes, which are then filled with a fluid insulating mixture, such as resin oil. These boxes are placed from 40 ft. to 300 yds. apart, as circumstances may require, the latter distance being only advisable when the cable is a light one and the pipe has a straight run. At Keswick the iron pipe is run up one of the wooden poles to a height of about 10 ft., and the overhead mains drop down to it, being provided with the surface-leakage arresters (Fig. 7).

There seem to be many advantages in this system, among which may be mentioned: The durability of the insulating compound and its cheapness; its high resistance; the freedom from all risk of explosion in the junction boxes, they being filled with oil; and the convenience with which access can be had to the cable, should occasion require it.

Many years ago Mr. Preece expressed a high opinion of this system, which has found great favor in America. A short line laid in London under his direction has, the authors learn, worked satisfactorily. About eight months ago Messrs. Johnson & Phillips, who represent Mr. Brooks in this country, laid a line of 700 ft. at their works at Charlton. In this line, 7 No. 18 cotton-covered and cotton-braided wires were tightly laid up together and again braided; this cable was drawn into the pipe in one length, and the whole system filled with oil as described. The line has since been subjected to some severe tests. The cable was divided into 2 circuits of 3 wires each (out of the total number of 7 wires), and these were joined to a 2,000-volt Kapp alternator, and frequent runs were made; careful trials, before and after the test, gave no indication of an alteration in the insulation.

Another interesting experiment, devised by Mr. Brooks and exhibited by Messrs. Johnson & Phillips, shows in a striking manner the insulation obtainable in this way: two fibre-coated wires are for a short length tightly twisted together, and this portion is placed in oil in a suitable vessel; the ends are opened out, and have sleeves of glass tube slipped on them, then water is poured over the oil. With this arrangement the ends in the air above the oil and water were opened out to a distance of 4 ins. and connected to an induction coil, the high potential of which preferred to leap the 4-in. air-space rather than find a passage between the closely-twisted wire immersed in the oil.

So far, the line laid in Keswick has given complete satisfaction.

The transformers are Kapp's patent, and they transform the high-tension current from 2,000 volts to 100 volts. The primary and secondary circuits are placed in coils alternately side by side. The sizes used vary from 10 HP. to 1 HP.; 22 are in use. The load can be increased above the normal 30% without overheating the transformer. A double-pole quick-make and quick-break switch, with double-pole fuse and lightning arrester, is used in the high-tension circuit with each transformer. Both the transformers and the switches are inclosed in cast-iron water-tight cases.

Water Power Electric Light Plant Tests, Keswick, England.

Number of experiment.	Rev. of turbine per min.	Head of water, feet.	Height over weir = h.	Cubic feet of water flowing per second. $Q = LC\frac{2}{3}gh^3$.	Constant C.	HP. in water.	Alternator.		Exciter.		Total electrical HP.	Efficiency, per cent.
							Volts (secondary circuit.)	Ampères.	Volts.	Ampères.		
1	250	19.780	1.0500	23.480	0.4180	52.76	96.5	14.65	114	8.30	39.600	75.00
2	255	19.830	1.0533	22.920	0.4180	51.60	100.0	13.90	118	8.50	38.650	75.00
3	249	19.710	1.0420	23.180	0.4180	51.80	92.0	15.00	112	8.37	38 255	73.85
4	250	19.520	0.9370	19.750	0.4177	43.80	100.0	10.60	114	8.50	29.700	67.75
5	250	20.180	0.8630	17.400	0.4174	39.90	100.0	9.00	112	8.00	25.330	63.50
6	246	20.260	0.8200	16.135	0.4173	37.10	100.0	8.00	111	8.00	22.640	61.10
7	246	20.140	0.7785	14.830	0.4170	34.00	100.0	7.00	111	8.00	19.950	58.65
8	241	19.900	0.7625	14.460	0.4170	32.75	100.0	6 00	108	8.00	17.240	52.70
9	252	20.308	0.7165	13.150	0.4167	30.40	98.0	5.30	114	7.50	15.045	49.50
10	235	20.520	0.6460	11.290	0.4167	26.32	97.0	4.00	106	7.75	11.540	43.80
11	242	20.750	0.5830	9.680	0.4170	22.82	99.0	2.85	106	7.65	8.646	37.90

The results of some trials of the machinery are given in the accompanying table. The curves (Fig. 8), representing the relation between the water power and the electrical output, have been plotted from these experiments.

With regard to the extremely high efficiency at full load of 75%, the authors wish to point out that no correction has been made for the velocity of the stream approaching the tumbling-bay, from the head over which the quantity of water flowing through the turbine was computed by the formula in column 5. Nevertheless, there can be little doubt that, were this correction made, the efficiency would still be very high. The velocity of the water approaching the tumbling-bay was about 1½ ft. per sec. The constant used with the formula is given in column 6, and was adopted from the experiments of Messrs. FTELEY and STEARNS,* the tumbling-bay used by them having similar dimensions to the one employed in the above experiments. A load-diagram (Fig. 9), taken on Saturday, the 29th of March, 1890, shows the load between the hours of 5 P. M. and 12 P. M. On account of the majority of the lamps being in hotels, it is probable that the maximum load will not be reached until the summer.

In connection with the arrangement of this central station scheme, the authors had occasion to make a comparison between the illuminating power of the glow lamp and gas; the results showed that the relative values usually given are misleading, as they almost invariably deal with a standard London argand, a burner seldom used for ordinary lighting. This burner is generally taken as giving from 15 to 16 c. p. for 5 cu. ft. of gas consumed per hour; whereas, out of a large number of ordinary burners taken hap-hazard, and tested where they were in use in Chester, Manchester and Keswick at various times, it was found that the light given by 5 cu. ft. of gas per hour was more frequently equal to 8 candles, or less. On the other hand, a number of Edison-Swan 16 c. p. lamps of various ages, from new lamps to those having been in use about 1,500 hours, were tested, and it was found that the difference between the new and the old lamps was in each case very slight. This would show that, in practice, one 16 c. p. incandescent lamp gives approximately the same degree of light as two ordinary burners, each consuming 5 cu. ft. of gas per hour.

This conclusion seems to be borne out by the result obtained by Dr. HOPKINSON, who, experimenting upon some ordinary burners, found the average candle power to be 1.76 per cu. ft. of gas. As regards incandescent lamps, Sir DAVID SALOMONS found that 100-volt 16 c. p. Edison-Swan lamps average 17 c. p. at 100 volts.

The current is charged for by contract in most cases; but in a few instances meters are being fitted. A trial is being given to the new Ferranti-Borel-Wright alternating-current meter. These meters read direct, are compact, and comparatively cheap; if in practice they are found reliable, they should supply a much-felt want.

As affording an interesting comparison between the small plant at Keswick and American practice on a large scale, we abstract from the *Electrical World* the following notes and cut of the central electrical plant at Spokane Falls, Wash.:

This city, situated on the Spokane River, has several waterfalls within its limits. One of these, some 70 ft. high, is utilized by the Edison Electric Illuminating Co. to furnish the necessary power for their dynamos.

The supply of water to run the turbines comes into the station through 2 steel penstocks, each 7 ft. in diameter. The upper portion of these penstocks is made of ¼-in. tank steel, the lower portion, where the pressure is greater, being made of 5-16-in. steel. The distance to the point where the water is taken is nearly 500 ft. These penstocks deliver 2,700 HP., and the volume of discharge passing through them when all the wheels are open is 425 cu. ft. per second, the amount of fall being 70 ft., as before stated.

All the wheels and hydraulic equipment are on the first floor of the station, the second floor being devoted to the dynamos and electrical apparatus, which is directly belted to the turbines.

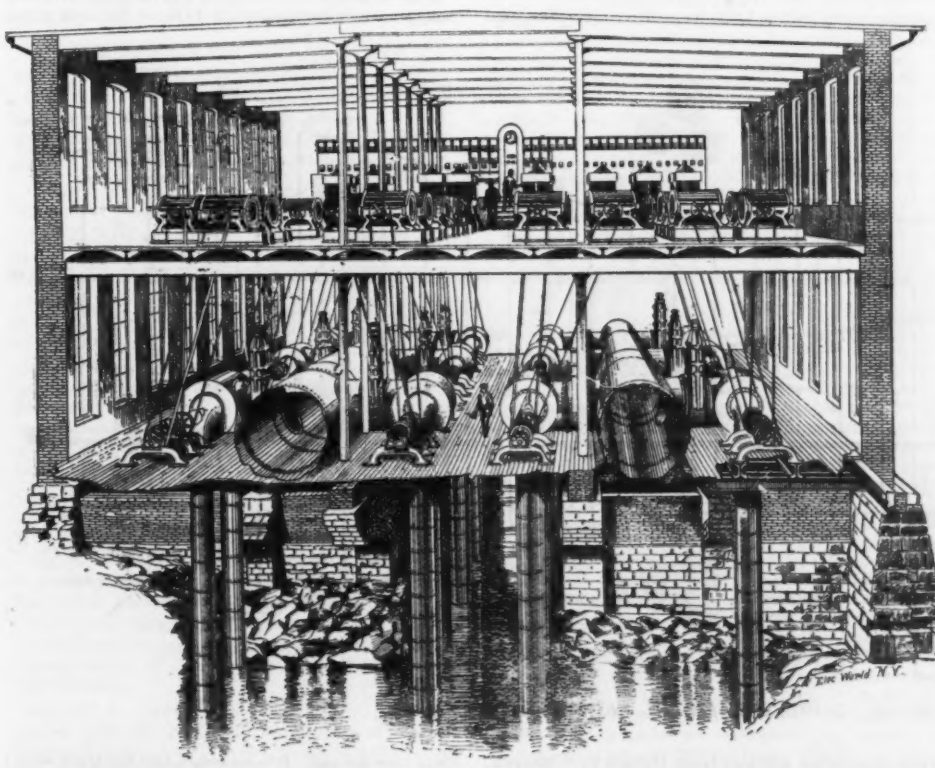
The wheel equipment consists of 12 pairs of Victor turbines of the twin horizontal pattern. Four pairs of these wheels are of 15 ins. diameter, and drive 24 Thomson-Houston arc dynamos of 50 lights each. The other 8 pairs of wheels are of 10 ins. diameter, and drive 16 No. 20 Edison dynamos. Friction clutch pulleys are used on the wheel shaft of the larger wheels, so that any one of the dynamos can be stopped at any time, should it be necessary, and still leave the others running.

The centers of the turbines are located 20 ft. above extreme low water, so that there can never be any danger of high water interfering in any way with their running. All the turbines run under a pressure due to 70 ft. fall of water, those driving the arc machines making 675 revs. per minute, and those driving the incandescent machines making an even 1,000 revs. per minute. In the arc department, each pair of wheels has a capacity of 375 HP. In the incandescent, the wheels have a capacity of 175 HP. each pair. Each set of turbines can be shut off from the penstock by a large gate, thus enabling a man to enter the wheel case to make repairs.

The water power designs have been carried out with the idea of duplicating as nearly as possible the perfection of small units of power as now in vogue in the best constructed Edison stations in the East. For instance, in the Edison department each pair of wheels drives a pair of Edison dynamos, and as there are 8 pairs of wheels driving 8 pairs of dynamos, any variation of load, distributed as it would be over the equivalent of 12,000 lights, would be unnoticeable to the consumer. In the arc department, where there is no variation of load to be noticed, the wheels are designed with the idea of carrying 6 machines each. The early lights run exclusively from 1 machine, and are usually all started and all shut down at the same time. The all-night machines, 6 in number, run from another pair of wheels. This arrangement is carried out in the entire arc department. The duplication of flumes has been found necessary after a long experience with water power, and will enable the company to shut down either of its flumes during the daytime without impairing the day service in any way; and, as already stated, any one of the water wheels can be shut off, leaving all the others in full operation.

The plans for this station and the designs for the hydraulic arrangements are the work of Mr. H. A. HERRICK, resident engineer of the Washington Water Power Co., under the superintendence of Mr. J. T. FANNING, consulting engineer, and gave evidence of great skill and care. The turbines, penstocks, and all the wrought and cast iron work used in the construction of the station were furnished under one contract by Stilwell & Bierce, of Dayton, O., the gross weight of the order amounting to 600,000 lbs.

The electrical plant, consisting of the dynamos, electrical apparatus for regulating and controlling the Edison system, and the switchboard and ampere meters for the arc circuits, are located on the second floor of the building. The floor space is so arranged that the plant can be increased, as the demand for light requires, up to a total of 12,000 incandescent lights and 1,200 arc lights, supplied by 16 No. 20 Edison dynamos and 24 Thomson-Houston 50 light arc dynamos. Fourteen of the Edison dynamos have a normal current capacity of 400 amperes each, but can be loaded considerably over this in case of an emergency, the E. M. F. being kept constant at 140 volts. The remaining two Edison machines are specially built for a normal current capacity of 300 amperes, but they can also be considerably overloaded if necessary. The E. M. F. of these two machines is 185 volts. These dynamos weigh about five tons each, and run at a speed of 700 revs. The arc dynamos are the ordinary pattern Thomson-Houston 50-light machines. They weigh three tons each, and the speed is 820 revs.



INTERIOR VIEW OF WATER-POWER ELECTRIC LIGHT STATION AT SPOKANE FALLS, WASH.

* Trans. Am. Soc. C. E., Vol. XII., p. 1.

A New Adjustable T Square.

Mr. E. L. DEANE, of Holyoke, Mass., recently invented an adjustable T square which is said to be meeting with considerable favor among the architects and engineers now using it. The cut shows the instrument with the head set at right angles to the blade. In order to adjust it to any other angle, the thumb lever, provided with a small cam at the joint, is raised, thereby loosening the connection between the parts and allowing the head to be set at any angle. A fine adjustment is furnished by means of a set screw at one end of the head as shown in

Deane's Adjustable T Square.

the cut. In this way the adjusting of the square takes but a moment's time. It will be seen that the blade is attached some inches to the left of the center of the head, thus giving the latter a longer bearing than usual when working at the bottom of the drawing board. Moreover, it is claimed that the piece which fits against the board is not attached so rigidly, but that the small motion due to expansion and contraction can be taken up by the joints, consequently maintaining a perfectly true bearing surface. The same maker also furnishes a square with a fixed head, set screw and adjusting bar. This square will doubtless prove of value to all who desire an instrument combining the advantages of a fixed head with the means of adjusting the same to compensate for the unavoidable expansion and contraction of paper and cloth.

Railway Construction in Northern Minnesota.

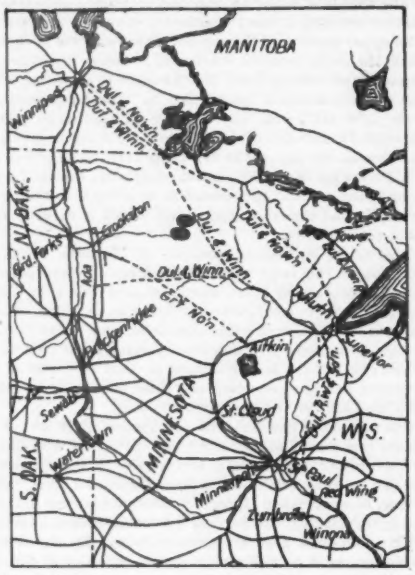
Perhaps no portion of the Northwest affords better opportunities for the profitable investment of capital in railway construction than the vast undeveloped plain of northern Minnesota. Lying north of the forty-seventh parallel, this great plain stretches from the valley of the Red River of the North to the shores of Lake Superior. In the central and southern portion lies the great Minnesota timber belt, including the region of the headwaters of the Mississippi and its various tributary streams and lakes; farther to the north and west are the rich agricultural lands of the Red River valley, and in

the east the rugged elevations of the Superior mineral formation penetrate well into the State. Of all this region only the extreme eastern and western portions have, until very recently, been supplied with railway facilities at all. In the west the Northern Pacific and Great Northern Companies had lines running north and south and in the east the Duluth & Iron Range R. R. penetrated the Vermillion iron district.

Recently, however, there has been a movement among railway capitalists toward the construction of railways into the great central territory. The pioneer company in this movement is the Duluth & Winnipeg R. R. Co., which was chartered in 1878. Work was commenced in the fall of 1888 and 20 miles of the road from Cloquet northwest were completed during the year. Early in 1889 suit was brought against the company restraining it from receiving a deed of the land granted in its aid by the State Legislature in 1878 on the plea that the company had not conformed with the requirements of the act. The greater part of the year was taken up in litigation over this point, no final decision being arrived at. The case has not been settled yet. In August, however, construction was resumed and the road completed to Grand Rapids in December 1889.

In January, 1890, the North Star Construction Co. was chartered in New Jersey with a capital of $1,000,000, the incorporators being men interested in the Duluth & Winnipeg R. R. Under the direction of this company work was resumed late in May, and about 50 miles had been graded up to Aug. 1. Further construction was then stopped by the Government, the company not having secured the right of way over the Winnibigoshish Indian Reservation. Negotiations are now in progress for the necessary right of way.

The map, which we publish in connection with this, shows the general route of the line. It passes north and east of Red Lake and west of Lake of the Woods, touching the latter, to the International boundary. At this point it connects with the proposed Winnipeg & Southeastern Ry., from Winnipeg Manitoba, southeast. South of Red Lake the road penetrates the pine timber lands of the great



Map Showing Railway Construction in Northern Minnesota.

whom are financially interested in the Canadian Pacific Ry. This has given rise to the belief that the Canadian Pacific Co. is at the bottom of the enterprise. It is probable, however, that while Canadian Pacific stockholders are interested in the new road the company is not backing it as a corporation.

Of the other lines shown on the map, the Duluth & Northwestern R. R. and the Great Northern extension have the same general direction as the Duluth & Winnepeg R. R., their routes lying respectively east and west of that road. The Duluth & Northwestern enters more directly into the mineral section, and it is probable that only a short section of the line from Duluth northwest to the mining lands will be built for some time. The road when completed will run from Duluth to Winnipeg, and will obtain a similar class of traffic to the Duluth & Winnipeg R. R. The Great Northern extension penetrates the heart of the pine region, and will connect the Red River Valley grain fields more directly with Duluth and the East.

Running south from Duluth, the Duluth, Red Wing & Southern R. R. is projected through the Wisconsin timber lands. A short section of the road has been completed, and it is probable that more work will be done soon.

The extension of the Duluth & Iron Range R. R. east along the Vermillion iron range has been on the *tapis* for some time. No work is likely to be done for some time, but with the further development of the mineral resources of this section, the extension is sure to be built.

The section of Minnesota which these roads penetrate is, of course, almost entirely undeveloped, and the roads will to a great extent be obliged to build up their traffic. The country is rich in timber, minerals and agricultural land, however, and it would seem as if the prospects for a paying business might be as good here as in any section of the Northwestern States east of Montana.

Rerailing Bridge Guard, Buffalo, Rochester & Pittsburg Ry.

The accompanying illustrations show one of the many excellent forms in which the idea of the Latimer rerailing bridge guard has been developed. We are indebted for the drawings to Mr. WM. E. HOYT, Chief Engineer of the road. In a note transmitting the drawing, he says:

I send you prints showing the rerailing bridge guard adopted for use on our road. Experience indicates that it is necessary for us to provide for *replacing derailed wheels on the track* before passing over bridges, and with this object the guard has been designed.

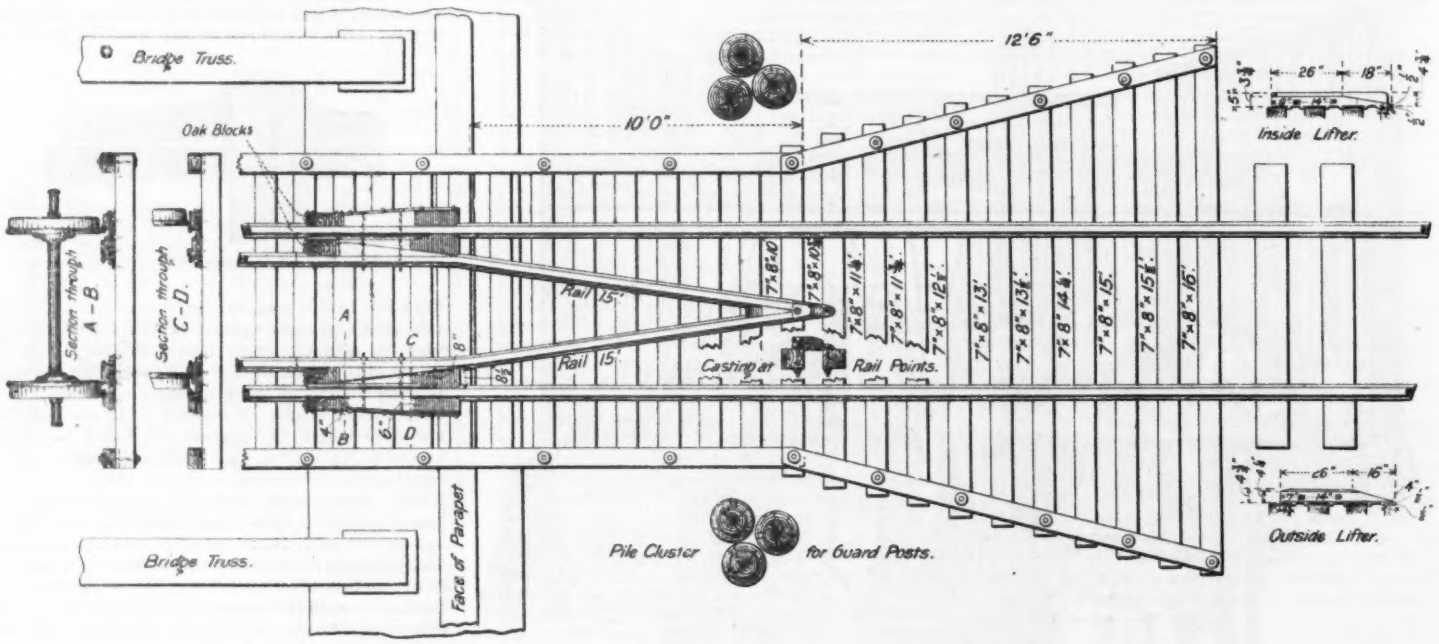
Allow me to call your attention to one or two special features of the device.

A space of 7 ins. in the clear has been left between the main rail and the inner guard rail, so as to allow the entire wheel to drop between the two rails in case of a derailment on the bridges.

It is considered that the chances of derailment are considerably less on the bridge than elsewhere; and, for this reason, it was thought best to use a beveled white oak block at the bridge end of the casting, rather than to lengthen the lifters to such an extent as to make them excessively heavy and unweildy in providing double inclined planes of iron for each one.

As you are aware, it has been the custom to extend the guard rails out on bridge approaches in the form of a curve. This seems to be unwise, for on a curved line of approach the derailed truck cannot be brought up to the lifters in such a way as to allow the front wheels to be properly guided for replacing them on the track.

If the back wheels of the truck hug the guard rail when laid on a curve the tendency is to throw the front wheels



RERAILING BRIDGE GUARD, B. R. & P. RY.—W. E. Hoyt, Chief-Engineer.

timber belt, into which various short branches will be built, by its proposed branch west to Ada. At Lake of the Woods a heavy lumber business will be obtained from the timber lands of western Ontario, the timber being driven down the Rainy Lake River and its various tributaries. The Red Lake Indian lands and the prairie lands of southern Manitoba are well adapted to grain growing and only need development to furnish a good business in agricultural products, also.

The projectors of the White Star Construction Co. are largely Baltimore, Md., capitalists, some of

away from the rail. It is necessary that the truck should come up to the lifter in good line, and as nearly parallel to the track as possible.

Then as to the guard posts. Our New York State statutes require railway companies to set short posts on all bridge approaches in a direct line with the bridge trusses. It cannot be denied that in some cases of accident these posts would do far more harm than good, and for this reason they are made only high enough to strip the trucks off the car body in case the outer guard rail fails to catch the wheels.

Placing the inner guard rail far enough off from the main rail to allow the whole wheel to drop between them if derailed is now very generally approved. The objection to the usual mode of flaring

outside guard rails seems to us less clearly sound. The only criticism we have to make on the bridge guard as a whole is that the outside guards flare too sharply, and are rather too short, and, above all, that the collision post is set too close to the bridge to serve its purpose, which is precisely that of stripping the trucks out from under the car, breaking the coupling, and letting the car body have some distance to slide before it reaches the bridge. This the posts are likely to do effectively if 100 ft. or so from the bridge; but when so near as shown in the cut they hardly have a fair chance to be useful under any circumstances, even to save the bridge, still less to save the car body from a fall into the river.

Legal Decisions of Interest to Engineers.

Granting Exclusive Privileges by Common Carriers.—An oral agreement made by a railway company with the owner of an omnibus line, whereby the latter was to erect an approach to the station platform and have the exclusive right to use a certain portion of the platform to secure passengers, is void as being in conflict with the Missouri constitution which prohibits "discrimination in charges or facilities in transportation . . . between transportation companies and individuals, or in favor of either." (Cravens v. Rodgers, Supreme Court of Missouri, 14 S. W. Rep., 105.)

Use of Street by Railway Company.—One whose lot only runs to the boundary line of the street cannot recover damages for inconvenience of access to his lot caused by the lawful building of a railway through the street. (Forbes v. Rome, W. & O. Ry. Co., Court of Appeals of New York, 24 N. E. Rep., 919.)

Negligence of Brakeman.—A brakeman cannot recover for injuries received in coupling cars, claimed to have been caused by the engineer's negligence in backing up the cars, unless he shows that he was without fault. (Western & A. Ry. Co. v. Vandiver, Supreme Court of Georgia, 11 S. E. Rep., 781.)

Stock-Killing at Public Crossing.—The mere failure of an engineer to sound his whistle and slacken the speed of his engine when approaching a public crossing constitutes negligence which will charge upon the company liability for stock killed at such time and place without contributory negligence. (Southern Kansas Ry. Co. v. Schmidt, Supreme Court of Kansas, 24 Pac. Rep., 496.)

PERSONALS.

Col. S. H. LOCKETT has returned to New York from the United States of Colombia.

Gen. Supt. BROWN, of the Michigan Central Ry., has resigned on account of ill-health.

Mr. J. MCCABE has been appointed Superintendent of the Pacific Division of the Northern Pacific R. R.

General Manager J. M. EAGAN has been chosen President of the Chicago, St. Paul & Kansas City R. R.

Mr. N. D. WIGGINS has been appointed Superintendent of the Mississippi Division of the Illinois Central R.R.

Gen. C. B. PECK has resigned his position as Vice-President and General Manager of the Atlantic & Danville Ry.

Mr. C. W. JOHNSON has been elected Manager of the Northern Pacific Terminal Co., with headquarters at Portland, Ore.

Mr. A. E. ROBBINS has been appointed Superintendent of the Toledo Division of the Columbus, Hocking Valley & Toledo Ry.

Mr. W. RUTHERFORD has been appointed General Master Mechanic of the Jacksonville, Tampa & Key West Ry., with headquarters at Palatka, Fla.

Mr. C. H. KETCHAM has been appointed General Superintendent of the Dunkirk, Allegheny Valley and Pittsburg R. R., with headquarters at Dunkirk, N. Y.

Mr. F. M. MERRILL, formerly Division Superintendent of the Wisconsin Central R. R., has been appointed Superintendent of the Eastern Division of the Great Northern Ry.

Mr. H. A. LATTA has resigned his position of Master Mechanic of the Toledo Division of the Lake Shore & Michigan Southern Ry., to accept a similar position on the Chicago & Erie R. R.

Mr. J. STEWART, formerly Superintendent of the Northern Division of the New Brunswick Ry., has been appointed Superintendent of the entire New Brunswick Division of the Canadian Pacific Ry.

Mr. J. M. LEE has been appointed Superintendent of the First Division of the Houston & Texas Central Ry., with headquarters at Houston, Tex., and Mr. D. ALLEN has been appointed Superintendent of the Waco Division.

Mr. GEORGE BERKLEY, Senior Vice-President of the Institution of Civil Engineers, will visit the United States in company with the members of the Iron and Steel Institute. Mr. BERKLEY was associated for many years with ROBERT STEVENSON on railway and other engineering works. At present he is Consulting Engineer of the Great Indian Peninsular Ry., the Natal Government Ry., and the Argentine Northeastern Ry.

Col. G. H. MENDELL, Col. H. W. CLOSSON, Col. A. R. BUFFINGTON and Maj. C. E. DUTTON of the U. S. Army have been detailed to examine the facilities on the Pacific coast and in the Central and Gulf States for producing steel forgings for high power guns. They will also report on the advisability of erecting gun factories for finishing and assembling high power guns in the same States. The first meeting will probably be held in New York City Sept. 15.

Mr. EMIL KUICHLING has been appointed Chief Engineer of the Rochester Water-Works, succeeding Mr. J. NELSON TUBBS, two members of the Executive Board voting for him, against one for the present incumbent. Mr. KUICHLING was born in Germany in 1848, but his father came to this country very shortly after his birth, being compelled to leave Germany for political reasons. He was graduated from the University of Rochester in 1868, took a post-graduate course in 1869, and thereafter a three years' course in Carlsruhe, Germany. He has since been chiefly connected with the various engineering interests of Rochester, but has also had important outside engagements.

NEW PUBLICATIONS.

SEPTEMBER MAGAZINES.

—*Harper's* is easily the magazine of greatest technical interest for September. It opens with the first description which has yet appeared of the noteworthy transandine line now building between Chili and the Argentine Republic. The heavy part of the work is only 151 miles in length, extending nearly due west from Mendoza (elevation 719 m.) to Santa Rosa de los Andes (820 m.) over a summit 3,189 m. high. It is an Abt system road, the Abt grades being 8 %, and the regular grades 2½ %. The gauge is one metre, and the maximum curve 100 m., although 80-m. curves are allowed by the concession. These are easier curves than are operated with perfect ease on the standard gauge Mexican Railway (4 % grades) where the minimum permanent radius is 325 ft., but curves of 150 ft. radius were, for a long time, successfully operated; but it is another curious illustration of the persistency with which narrow gauge advocates hug their delusions that we find it claimed in the article; doubtless, by inspiration from the engineers of the road: "The adoption of this narrow gauge will necessitate the transfer of goods and passengers at Mendoza and Los Andes, which is, of course, a serious disadvantage; on the other hand, it enables the line to be built at much less expense, *and permits sharp curves of short radius, whereas a broader gauge would require curves of* 250 *to* 300 m." It would be amusing if it were not so serious a matter, to find engineers charged with the expenditure of millions of money hugging such delusions as this. A 300 m. radius is equivalent to about a 6° curve.

The first survey of this route was not completed until 1887; there is plenty of money for building it, and it is expected to open it in 1895. The line includes many tunnels, including one helicoidal in the style of the St. Gothard Railway, 1,885 m. long and dropping 135 m. or about 532 ft. on an 8 per cent. grade. Another transandine line to the north of this is also projected and another (and better) line to the south (the Busttamente line) is actually under construction, of the standard Chilian gauge of 5½ ft., and crossing the Andes at an elevation of only 6,000 ft. It will be completed in about six years. It is one of the curiosities of history that South America, which was discovered but yesterday, should be so nearly subdued to civilization, while Africa, where history almost began, should be even now nearly as it was thousands of years ago.

In part, no doubt, this is due to the metallic wealth of South America, and in still greater part to the causes subtly analyzed in a paper by N. S. SHALER on "Nature and Man in America," which appears in *Scribner's*, and is perhaps the most notable single article in this month's batch of magazines. It is pointed out in a most interesting and conclusive way that the physical characteristics of Europe had probably more to do with its becoming the sole seat of a high civilization than any difference in the original qualities of the races inhabiting it; in that it is so cut up into peninsulas, islands, and mountain district as to afford chance for the segregation and peaceful development of several different races, without the savage wars between neighboring people, which have held many races in barbarism. The North American Indian, for example, had many fine racial qualities, and great natural abilities. A few centuries before the white man came here they had already advanced far above savagery, and were the original mound builders, but a zoological accident, the spread of the buffalo over the whole continent, drove them back into savagery by removing the need to toil for subsistance. It is certain that the buffalo was not known to the mound builders, and hence that he must have very lately begun to multiply on the scale he did. The relative fortunes of the French and English are also ingeniously explained on geographical grounds, with an element of truth no doubt, but perhaps too subtly, since the Anglo-Saxon race has always dominated, wherever it has settled. This paper is the first of a series. Another interesting technical article in *Scribner's* is on the "African River and Lake System," showing remarkably abundant natural means of communication, which, however, on Mr. SHALER'S theory, would tend to impede the rise of savage races to civilization, as something certainly has done.

A short article on the metric system, giving in outline the rather remarkable anticipation of that system by JEFFERSON, which unfortunately was not adopted while it was yet easy to make the change; and an exceedingly interesting paper on the "Mountain Passes of the Cumberland," by JAS. LANE ALLEN, are the other technical articles of *Harper's*. It is quite impossible to abstract the latter paper properly in small compass; it should be read by all those who take an interest in the remarkable development which is now taking place in that hitherto benighted and primitive mountain region, which bids fair to become in the near future the very center of the iron and steel industries of the continent, leading both Pennsylvania and Alabama.

In the same issue Prof. CHAS. ELIOT NORTON has an article on Harvard University in 1890, highly eulogistic of course, which we examined with great interest to see if any explanation was offered therein of the almost total collapse of the Lawrence Scientific School, one of the earliest and (at one time) most liberally endowed technical schools of the continent, with all the prestige of Harvard added to help it to early prominence. We need not say to engineers that all these opportunities have been wasted, and that the school is for some reason in a state of ridiculous decadence, while many newer institutions, with no prestige to help them, have jumped into prominence within a few years. Seeking for an explanation, we speedily reached in the article the statement that "The progress of the university as a true school of learning has been nowhere more marked of late than in the improvement of its professional schools;" but only to find that Law, Medicine and Divinity were the only ones which were even mentioned; engineering, apparently, not being regarded as a profession. Perhaps this is the explanation of the decadence of the Lawrence Scientific School; certainly no other is offered.

The present purpose, as we understand it, is to abolish the Scientific School as a separate department of the University, but to constitute instead a sufficient number of electives in the regular course to enable students to take something like the usual course in engineering if they choose. At first sight there is something to say for this plan, but a second sight will reveal many reasons why it should not be effective, but rather lead to Harvard's ceasing to be an advantageous resort for instruction in the applied sciences—a consummation which would almost seem to be not unwelcome, from Prof. CHAS. ELIOT NORTON'S complete silence as to this immense factor in modern intellectual life, but which, in our judgment, means a continuing loss of prestige to Harvard, and a just one.

—The *Century* contains an excellent short article on "Our New Naval Guns," which most engineers not directly connected with military affairs will find interesting reading. It is, of course, highly popular in style, and passes many details which engineers would be glad to see more fully discussed. A further article on the proposed new Yosemite Park, which is to be about 25 times the area of the present park, and under national instead of State control should do much to hasten this desirable change by its revelation of its absolute necessity, if the present park is to be preserved, and of the many new and grand features which would fall within the enlarged boundaries, including another Yosemite of almost equal grandeur.

—*The Forum* contains a particularly good article by Prof. CHARLES A. YOUNG on "The Latest Astronomical News," which we cannot attempt to abstract, but the most significant items of which are the discoveries as respects double stars which we noticed last month. It is stated that a niece of Dr. HENRY DRAPER did the delicate spectroscopic work which led to these striking discoveries, the first which have afforded an opportunity for directly measuring the mass and volume of any of the fixed stars. Lieut. J. P. FINLEY, of the Signal Service, considers "Protection against Tornadoes" possible by predicting districts of each State where tornado conditions prevail leaving local observers to determine from easily recognized local signs whether a tornado is coming at particular points. Tornado insurance, however, is the only feasible protection against the pecuniary loss therefrom; no difference of construction, however massive, can afford sensible protection.

—The *North American Review* contains little of real technical interest. A somewhat hysterical article on "Can Gold be Manufactured?" opens, with some interesting chemical information tending to prove, what is doubtless the fact, that our present ideas as to what are and what are not elements are all astray, and that it is quite among the possibilities that gold may yet be manufactured from other elements. But the article ends with some very silly reflections on the slavery of mankind to "the yellow-faced king, Gold," and the relief therefrom which would come by manufacturing gold in quantities, as if the slavery were to gold as a metal, rather than to the exchange values which it is used to represent, and which would remain unchanged (except as respects gold) however much gold might be manufactured.

—*The Popular Science Monthly* is chiefly devoted to political, social, anatomical and botanical science, and

contains not an article worthy of note relating to the exact sciences.

BOOKS.

—*Earthwork Slips and Subsidences upon Public Works.* Their Causes, Prevention, and Reparation; especially written to assist those engaged in the Construction and Maintenance of Railways, Docks, Canals, Roads, Water-works, River Banks, Reclamation Embankments, Drainage Works, etc. By JOHN NEWMAN, Assoc. M. Inst. C. E., London and New York; E. & F. N. Spon, 12mo., pp. 234; $3.

In attempting to reduse to something like law "earthwork slips and subsidences," and to point out in a book the proper method of dealing with them, it will be apparent that the author has chosen a large and difficult subject. Could he discuss it in an ideally perfect way, so as to point out the necessary precautions to be taken in any given case, he would produce one of the most valuable of engineering treatises. As it is impossible to do this, and very difficult to discuss the subject on paper effectively at all, he is entitled to every charity in considering his work. If he even sheds a little light upon the subject and helps to avoid a few errors, he has done enough to justify the publication of the work; and so much, perhaps, it may be admitted that he has done.

But it does not increase one's sense of the probable value of the treatise to find on opening it that it contains but a single engraving, and that an unimportant one; and the impression which this fact is likely to convey is not an unfair one. In so essentially indeterminate and practical an art as that of constructing stable earthworks, which depends so largely on experience and so very little on general theories, example is far better than precept. The ideal treatise would be merely a large collection of actual instances of "earthwork slips and subsidences," with the remedies which had proved effectual against them. Such the present work emphatically is not; it gives but very few specific instances of actual failures. It contains on almost every page some sound practical truth which the young engineer needs to know (and soon learns in practice), so that one hesitates to condemn the work; but it is far too largely a collection of mere "words, words, words"; of hair-splitting distinctions and impossible or hypothetical refinements, or else of mere platitudes, "saying in a solemn way an undisputed thing." The book has not a practical ring to it; we infer from it with some confidence that the author has gained his knowledge of earthworks more from books than from experience, although this inference may do him injustice. But what can be said of such sentences as the following, which we choose purely at random?

Obviously, vibration is increased with the speed and weight of a train; probably a short, heavy train traveling at high speed causes a more deleterious effect than a long heavy train traveling at a slow speed; also, the higher an enbankment or the deeper a cutting the greater the area of a cross-section. It might be considered that the effects of vibration would be less as the areas increased. [Then follows a tabular computation of the ratio of the weight of one foot lineal of the bank to the weight of a 100 ton train—a pretty light train.]

Merely comparing the weight of a train with that of an embankment, and assuming that the results of vibration at the same rate of speed are so governed is incorrect, for the effect of vibration at the formation level is not regulated by the height of an embankment or the depth of a cutting. The weight of a train may bear a very small relation to that of the quantity of earth slipped, yet the soil may have gradually become in (*sic*) such a state of delicate equilibrium that at last the least vibration will destroy it—even a little of the top soil falling on the slope; and it frequently occurs that a slip commences by the detachment of a few small lumps and increases until it becomes of serious dimensions; therefore, the area of a cutting or embankment cannot necessarily be considered as reducing vibration, although the source of disturbance may be more distant; but, of course, the heavier the mass the greater the weight and speed required to cause the whole to vibrate.

Except from actual experiment in each case, it is impossible to determine the greatest weight of and the speed at which a train should be allowed to travel so as to present any deleterious effect from vibration, and the circumstances are so various that a practical rule cannot be deduced, except by assuming conditions from experience alone, which would so modify a formula as to make it show any desired result, and cause it to be regarded as too complaisant to be trusted.

All this (two pages) to say in objectionable English, which the proofreader should have corrected, what any tyro should know by intuition, but which after all is *not* said; that a high bank is much more likely to shake down or slip down than a low one! We began the quotation simply as an example of bad and verbose style, but toward the end of it, found that by implication, at least, it stated that the greater the mass of the earthwork the less the probable effect of vibration, which is the reverse of the truth. The incipient engineer will likewise justly infer from the language quoted, that when his rank is high enough up he will be allowed to regulate the speed of trains to keep his earthworks from shaking!

Similarly on page 96 we have a table of the "approximate safe permanent maximum height" of embankments of 12 different kinds of earth, ranging from 7 to 120 ft., which can only be described as nonsense. "Alluvial soil, loam and loamy earth," for example, is limited to 15 to 30 ft., but the whole table is absurd and based upon an absurd premise, that the weight is transmitted downward by the road-bed prism, and not transmitted outward through the slopes. Ranks of any of the 12 kinds of earth specified can be built to any height whatever, with perfect safety.

So we might go on, and note a variety of other no-such-things, hair splitting distinctions of no moment, and needless verbosities, like the discussion of the slopes assumed by various earths, for example. But we prefer rather to say what good we can of it in our brief remaining space. It is the only book of its kind that we know of; it is on an important practical subject; it is beautifully printed and bound (like most English technical books, which are far and away ahead of most of our American publishers' output); it will do the young engineer good to read it, by making him realize how much chance there is for mischances in earthwork construction, and by giving him here and there valuable practical points, if only he will not trust to the book, nor take any part of it for gospel; but should he take it too seriously, and try to follow it implicity, he will speedily make himself ridiculous among his practical colleagues. We should add that the author wholly passes by American methods of earthwork construction, of which he does not appear to have heard. "Plow," "Scraper," "Train," and even "Shrinkage" are absent from the index. If the fact that excavated earth shrinks when placed in bank is anywhere stated we have not discovered it, and certainly no table of this shrinkage is given, nor is it mentioned among 38 different causes for "slips and subsidences" in embankments which are listed. Altogether it is a pretty thin book, and yet one which may be convenient to refer to in cases of doubt.

REPORTS.

—*Proceedings of the Institution of Civil Engineers.*—"The Keswick Water-Power Electric Light Station," by W. P. J. FAWCUS and E. W. COWAN; pp. 39, with large plates. "*The Screw Propeller*," by S. W. BARNABY; pp. 82, with plates giving diagrams of efficiency. "*The Probable Errors of Surveying by Vertical Angles*," by WILFRID AIRY; pp. 11. "*The Coasts and Rivers of Yesso*," by CHAS. S. MEIK; pp. 12, with map. "*Artesian Wells in South Lincolnshire*," by JNO. C. GILL; pp. 6. "*The Application of Electricity to Welding, Stamping and other Cognate Purposes*," by SIR FREDERICK BRAMWELL; pp. 74; with 27 illustrations and tables. "*Wire Ropes*," by ANDREW BIGGART; pp. 20.

TRADE PUBLICATIONS.

—*Illustrated Catalogue of Traction Engines and Threshing Machinery*, manufactured by L. SPENCE, Martin's Ferry, O., p. 12.

—*Block Signaling.* Catalogue of the Hall Signal Co. New York and Chicago. 4to, pp. 53, numerous plates and cuts.

This beautifully printed manual is really a technical treatise on the Hall Block Signal System rather than a catalogue in the ordinary sense. The description of the plant is very complete and well prepared, and to it we are chiefly indebted for the information in regard to this system, which has made for itself a most excellent record, which appears in this and our following issue.

—*Official Reports of Various Duty Trials of the Gaskill Pumping Engines.* Buffalo, N. Y., 1890. Holly Mfg. Co. Cloth, 6¼ × 9¼ ins., pp. 229. Illustrated.

This volume, while in a sense a trade publication, as published for business, is really a most valuable collection of technical data in regard to pumping engines. It contains the official reports of tests of 27 Gaskill pumping engines. The tests were made in the years 1882 to 1890, inclusive, by the most noted experts in the country. The smallest engine tested has a daily capacity of 1,500,000 galls., and was built for the water-works at Burlington, N. J. Each of the two largest engines has a daily capacity of 20,000,000 galls. One was built for the Philadelphia, the other for the Buffalo water-works. Of the 27 engines tested 22 showed a duty of over 100,000,000 ft lbs. per 100 lbs. of coal, ranging from 101,183,587 for one of the engines at Washington to 125,907,297 ft.-lbs. for the engine at Buffalo. The second Saratoga engine showed an apparent duty for the first twelve hours of its trial of 127,170,000. The first Saratoga engine has a record for the years 1884 to 1889, inclusive, as follows:

Average duty for the year				1884	105,425,937
"	"	"	"	1885	101,700,644
"	"	"	"	1886	105,940,690
"	"	"	"	1887	106,318,872
"	"	"	"	1888	108,401,880
"	"	"	"	1889	107,676,411

Average duty for the six years, figured directly from total coal consumed, with no deductions for ashes, steam for heating or other purposes, 105,910,739.

It should be stated that this Saratoga engine was the first Gaskill engine built, and that the contract called for a duty of but 65,000,000 ft.-lbs.

The latest test included in the report is that of the 10,000,000 gall. engine at Nashville, Tenn., tested in 1890.

In addition to the reports of the various tests the volume contains a short history of the Holly Manufacturing Co., a brief description of the Gaskill engine, with sections and details, a short sketch of the inventor, Mr. HARVEY F. GASKILL, and a list of all the pumping engines built by the company since 1863. The total number of engines built to January, 1890, was 358, with a combined daily capacity of 1,077,150,000 galls. Of these, 118 Gaskill engines, with a combined daily capacity of 555,000,000 galls. have been built since 1882.

The records shown in this volume are both extremely remarkable and valuable. The reports of none of the tests could well be omitted from the library of a hydrants engineer, and the Holly Manufacturing Co. are to be congratulated upon being able to present 27 such tests to the engineering profession, and are to be thanked for having brought them together in a handy volume. We hope to say more about the tests in a future issue.

SOCIETY PROCEEDINGS.

—*Roadmasters' Association of America.*—The eighth annual convention of this Association was called to order at 10 A. M., Sept. 9, at Detroit, Mich., by President John Sloan (O., I. & W. Ry.), who made a brief address congratulating the Association on its prosperity and on the favorable auspices under which the current meeting was held. A letter was read from the Mayor of the city giving the Association a formal welcome to Detroit, and brief remarks were made by Past President J. W. Craig (Charleston & Savannah), G. W. Bishop (Fitchburg), and Jno. Doyle, Chairman of the local reception committee. The roll-call followed and about 45 members responded to their names.

The list of applicants for membership was then read, and about 40 new members were admitted.

The question of approval of the minutes of the Denver meeting, as printed, was then taken up and discussed for some time. Great dissatisfaction was expressed with the report, and with the stenographer who had taken it. Several corrections were made to the report as printed, and a number of schemes were proposed for avoiding such flagrant errors in the report of the present convention. The latter discussion was finally ruled out of order, and it was voted that any further corrections to the report of the Denver meeting should be made in writing at the second day's session. Mr. J. W. Craig called attention to the fact that no formal reply had been made to the letter from the Superintendents' Association on the subject of standard frogs, and the secretary was instructed to report the action taken at the Denver meeting to the Superintendents' Association.

Reports were called for from the committees appointed upon the various topics for discussion, but none were ready. Mr. H. W. Reed moved to suspend the rules for the introduction of a resolution providing for the appointment of a committee to revise the constitution and by-laws. The motion was defeated by a vote of 18 yeas to 21 nays, and the convention adjourned until 2:30 P. M.

AFTERNOON SESSION.

The question of the appointment of a committee to revise the constitution came up again, and on motion the President was empowered to appoint such a committee to report at the next annual meeting. The committee appointed were J. W. Craig (Charleston & Savannah), C. E. Jones (C., B. & Q.), Jno. Doyle (Det., Lans. & No'w.), Jas. Sloan (Chic. & East Ill.), and O. F. Jordan (Mich. Cen.)

The report of the committee on nut locks, track bolts and spikes was read by H. W. Reed (Sav., Fla. & Western). It was in substance as follows:

We recommend that in general railroad officials should exact and manufacturers should give more attention to quality in the production of track fastenings. Nut locks are of two general classes, positive and elastic. We do not think it best to recommend any special manufacturer's product, but think the nut lock should conform to the following general specifications: For general main line use we favor an elastic steel nut lock washer, with high temper, requiring at least 3,000 lbs. to compress it to a full bearing. The maximum compression should be 5/8 in. For frogs and crossings we advice the use of either an elastic washer requiring at least 6,000 lbs. to compress it to a full bearing, or a positive nut lock. An elastic washer should have a total bearing surface of at least ¾ sq. in., and a full inch would be better. The compression on screwing up the nut should not exceed 80% of the total possible. A lock should be used on every bolt.

Track bolts should be ¾-in. for 50 to 60-lb. rail, ⅞ in. for 60 to 80-lb. rail and 1 in. for rails above 80 lbs. 1-in. bolts should be used on all frogs. The end of the bolt should project not more than ¼ in. when the nut is screwed home. The bolt should have a round head with an oblong shoulder next to the head. The nut should be hexagonal, with a thickness and a width of side equal to the diameter of the bolt.

Spikes should be of steel of the general pattern of those now in use. They should be 5½ ins. long, with a diameter under the head of 9-16 in. The points should be so made that the spike will drive without turning from the rail and with as little injury as possible to the tie. We favor a steel spike, because if properly tempered it will wear better where the rail bears against it and is stronger than an iron one of similar size.

In discussing the report Secretary Ramsey said the general practice was to screw up the nuts tight. He favored a square nut with the corners chipped a little rather than a hexagonal. J. Kindelan said that if the nut were screwed up tight the rail could not expand and contract freely. After some further discussion the report was adopted without change.

The report of the committee on track joints was read by the chairman, Robert Black (Manhattan Elevated). The report stated that, while other improvements in railway appliances are rapidly introduced, new improvements in track joints are slow to find favor. The committee believe, however, that ere long rail joints will come

into use as far ahead of the angle-bar as that was ahead of the plain fish plate. Several months ago the committee sent out a circular letter to manufacturers and inventors of improved rail joints all over the United States, asking for a sample joint with a test sheet signed by a civil or mechanical engineer, showing the behavior of the joint under various test loads, and inquiring if they would furnish their joints for an official trial on certain roads.

Responses to this inquiry were very numerous, and of the great number of devices submitted to the committee there were but few that did not contain some valuable features. From these various joints the following were selected as on the whole the most promising: The Weber joint, the Long Truss joint, made by the Long Truss Rail Joint Co., of Chicago; the continuous rail joint, made by McConway, Torley & Co., Pittsburg, Pa.; the latest improved Fisher joint, made by Clark Fisher, Trenton, N. J.; the Cloud double-angle joint, made by the Dunham Manufacturing Co. The makers of the above joints will furnish as many as may be needed for testing in actual service, and the committee recommended that the executive committee be instructed to make arrangements for the further carrying out of these tests. The report was accepted by the convention.

The report of the committee on the preservation of cross ties was called for, but no member of the committee was present, and on motion the President appointed a new committee to report at a later session of the convention.

The report on the best method of instructing section laborers to fit them for section foremen was read by R. Caffery, chairman of the committee.

The report stated that the wages paid section hands were very low, while a good foreman must have the qualifications of a first-class mechanic. The problem is therefore a difficult one. In the Southern States apprentice gangs have been established for educating track foremen, and attracting a better class of labor to the work. The lack of good section foremen is less felt in the North; but something is needed even here to secure young men of intelligence and honesty for section foremen. The report, therefore, recommended that an assistant foreman should be appointed on each section and each floating gang. The appointment should be made by the roadmaster on the recommendation of the foreman and the endorsement of the supervisor. Whenever a foreman has to leave a gang the assistant foreman should have charge. If a foreman is removed or promoted, the assistant foreman shall have charge until a new foreman is appointed. The assistant foreman should have an increased rate of pay over the ordinary trackman.

In discussing the report, Mr. H. W. Reed (Sav., Fla. & W'n.) gave his experience with the apprentice gang system. He did not see why conditions should not be the same in the South as in the North. He had had an apprentice gang for 10 years now. The foreman of the gang was a very good man, above the ordinary grade of section foremen, and took pains to instruct the men under him in every class of work. Ordinary section foremen, on the other hand, were apt to be jealous of the men under them and would often try to keep them from learning, if possible. Work is not the same on different sections. An apprentice gang can be put where they will meet the greatest variety of work and receive the most training; they are used for special work in yards, on new work on main line, laying sidings, clearing up wrecks, etc. The result has been a marvelous increase in the efficiency of the section foremen. In answer to questions, Mr. Reed said he had 80 regular sections. He paid the foreman of the apprentice gang $2.50 per day. The men are paid 75 cents the first year, $1 the second, $1.25 the third and $1.50 the fourth year There are about 30 men in the apprentice gang, and we cannot graduate them fast enough to supply the demand for section foremen both from our own and other roads.

J. KINDELAN suggested that one way to educate the foremen was by inducing them to read track literature. Another good plan was to bring experienced foremen together where expert foremen are at work.

Secretary RAMSEY offers as an inducement to his men to excell, that he will not take on any outside men when he can get foremen among his section laborers. Each man therefore, hopes for and works for promotion. He thought the system of promoting the foreman's "right-hand man," recommended by the committee, a good one.

There was a general sentiment expressed in brief and very pithy remarks by several members that to pay good wages was the best and surest way to secure good section foremen.

The discussion then drifted on to the general subject of wages. In the North Central States $1.10 per day was the general average of trackmen's wages. The Fitchburg and the New York, New Haven & Hartford, which were the only New England roads represented, had the highest scale of wages; $1.50 to track hands, $1.75 to "second hand" in gang, and $2.50 to foremen, the latter being chosen from the second hands in the gangs, were the wages paid on the Fitchburg. The rule of that road was that every man was in the line of promotion.

It was claimed, however, that in the West, where living is cheap, very good workmen could be got for $1 to $1.10 per day. It was finally voted to kill the report of the committee by "striking out the enacting clause," and the question was resubmitted to the committee. Adjournment was then taken until the next day.

WEDNESDAY MORNING.

At the opening of the session the chairman appointed W. F. Ellis, W. H. Stearns, J. A. Kerwin, John Tudhope and J. M. Mead a committee on resolutions.

Mr. I. Burnet (Ill. Steel Wks.) was appointed chairman of the committee on revision of the constitution in place of J. W. Craig.

The report of the committee appointed to procure plans of interlocking devices was presented by the chairman Jno. Wynn (St. L. Bridge Co.) The committee had corresponded with the Union Switch & Signal Co. and the Johnson Switch & Signal Co. and had procured from them blue prints of interlocking machines and appliances. These were explained to the convention by Robert Block, of the committee. Many questions were asked as to the relative merits of pneumatic and mechanical interlocking.

It was generally agreed that roadmasters needed to familiarize themselves with interlocking apparatus, especially the ground connections, so as to be able to intelligently direct their men when placed in charge of the track connections. To separate the interlocking department from the road department, it was stated, generally resulted in a conflict of authority.

The subject of the proper place for home and distant signals came up and it was stated that in Illinois the rule of the Railroad and Warehouse Commissioners is to have the home signal at 400 ft. and the distant signal 1,200 ft. from the crossing.

It was voted that the committee's report be accepted, and that the plans be published in the report.

The committee on the best method of instructing section laborers reported that they could not consistently make any report other than the original one. A very active discussion then began over this report. Many members were opposed to having an assistant foreman in a gang on account of the jealousy likely to arise between the foreman and the assistant. It was attempted to repeat the action of the previous day and strike out all reference to assistant foremen from the report, but the motion was defeated by a vote of 16 to 40.

On motion of J Kindelan the report of the committee was amended by a vote of 32 to 15 to place the appointment and discharge of the assistant foreman in the hands of the foreman instead of the roadmaster. The report was also amended by striking out the reference to young men as the most desirable for section foremen. The report as amended was then adopted.

A brief paper was read by J. W. Craig on Statistics of Railroads in the United States and Foreign Countries. The matter of a proper badge for the association was brought up, and Robt. Black (Manhattan Elevated) was appointed to secure designs and submit them at the next annual meeting.

On motion of Mr. Craig it was voted to instruct the Executive Committee to leave out from the printed report of the preceding day's discussion the irrelevant matter pertaining to wages of trackmen on different roads. An adjournment was then taken until 1:30 P. M.

AFTERNOON SESSION.

The report of the Committee on the Preservation of Cross-Ties was read by H. W. Reed (Sav., Fla., & Wn.). The report stated that to properly treat this subject months would be required, instead of the single day given the committee. They recommended, therefore, that a permanent committee be appointed; and for the present submitted a paper prepared by the chairman of the committee on the general subject of the preservation of timber.

On motion the same committee was continued, and the report was received and ordered printed in the proceedings.

The report of the Committee on the Revision of Constitution and By-laws was called for but was not ready, and the matter was put over until the next year. The Committee on Resolutions asked for more time to complete its report.

The election of officers then took place. John Doyle and John Sloan were placed in nomination for the presidency. A ballot was taken and resulted as follows: Doyle, 32; Sloan, 29.

For first vice-president, G. M. Brown, J. M. Mead and W. H. Stearns were nominated. The ballot resulted as follows: Stearns, 29; Brown, 15; Mead, 25; Jas. Sloan, 3. It was voted to drop the two candidates having the least number of votes, and a second ballot was taken, resulting in a tie, 35 votes being cast for each candidate. A second ballot resulted in the choice of W. H. Stearns (C. & N. W.) by a vote of 37 to 34.

For Second Vice-President J. Kindelan, J. Wynn and Jas. Sloan were nominated. The ballot resulted as follows: Jas. Sloan, 30; J. Kindelan, 18; J. Wynn, 10.

The convention here adjourned to the wharf, where the steamer *Idlewild* was waiting to take the association on an excursion to Star Island in Lake St. Clair.

The following new members (to the number of 43), were elected:

Jno. Sweeney (D. & R. G.), Jno. McMahon (D. & R. G.), M. J. Commerford (Kings Co. El.), Jno. Griffin (C., S. & C.), R. J. Anthony (Mex. Nat.), C. M. Clark (Mo. Pac.), E. C. Perkins (Mex. Nat.), P. F. King (Mo., Kan. & Tex.), J. P. Fisher (Mo., Kan. & Tex.), John Ennis (Wabash), S. Littlefield (R. W. & O.), Jno. Hassett (U. Pac.), J. A. Prentice (L. S. & M. S.), M. J. Brew (L. S. & M. S.), E. P. Hawkins (Mobile & O.), F. S. Bowen (G. Rap. & Ind.), Jno. W. Clark (Chic. & W. Ind.), W. H. Connors (Wabash), N. Brown (Det., B. Cy. & Alpena, David Bailey (R. & D.), M. H. Burkhalter (So. Pac.), T. Ahern (So. Pac.), P. J. Adams (B. & O.), O. M. Grady (Ga. So'n & Fla.), D. R. McGuire (Mo. Pac.), A. W. Hedeen (A., T. & S. F.), A J. Taft (So. Pac.), P. Madden (C., M. & St. P.), K. Nelson (C., M. & St. P.), J. O. Bryan (Chic. & Now'n), Jas Burke (M., St. P. & S. S. M.); C. H. Newman (C. & D.); Jas. Hughes (Chic. & Ind. Coal); D. Riley (C., C., St. L. & C.); D. P. Beatty (Chic. & E. Ill.); M. Burke (C., C., St. L. & C.); E. Hogan (L. E. & W'n); E. S. Shaughnessy (G. Rap. & Ind.); W. T. Hargrett (Bruns. & W'n); Robt. C. Sattley (Chic. & Now'n); P. Maloney (Norfolk & W'n); W. L. King, (Dayton, Ft. Wayne & Chic.); W. J. McLaren (T., C. & C.)

EXHIBITS AT THE CONVENTION.

The room for the exhibit of railway appliances was by no means an attractive one; but a very respectable exhibition was made of devices in which the permanent way departments are interested. Of course the most prominent exhibit was in hand cars. Fairbanks, Morse & Co showed two Sheffield hand cars with solid steel wheels and wood wheels, also two velocipedes, one of which was an "odometer car" for measuring distances in feet to locate frogs, bridges, switches, etc. The measuring wheel has a straight tread to insure accuracy, and the distance traversed is shown on a counter. Other exhibits of the firm were the Barrett track and bridge jack, the Smith-Vaile steam pump, Eclipse water tank, and the Sheffield stand pipe.

The Kalamazoo R. R. Velocipede Co. was represented by President G. W. Miller, and showed two standard hand cars and a 4-wheel velocipede, also their new spring steel surface cattle guard, which very much resembles a woven wire mattress.

Rail joints were exhibited in profusion. The McConway & Torley Co., of Pittsburg, represented by Mr. Aikman, showed one of their "continuous" rail joints applied to a rail which had been in actual service. The rail had been on the track of the Manhattan Elevated Ry. four years and was battered 1/8-in. low. The clamp was then applied and brought the rail back to surface. The traffic over the joint is 420 trains per day, 3,679,200 wheels per year.

Long's truss rail joint (illustrated in ENGINEERING NEWS Dec. 8, 1889), was exhibited by Mr. Brewster These joints are now in use on the C., B. & Q., Chicago & Northwestern, Flint & Pere Marquette and other roads. The Standard rail joint, a Boston invention, which dispenses with bolts, and is to be put on a mile of the Old Colony soon, was shown by several full size joints, one of which had been in the track for 27 months.

A. W. Thompson, Newark, N. J., showed the continuous rail joint, an angle bar and chair combined.

Clark Fisher, Trenton, N. J., showed a Fisher joint which had stood the hard test of long service on the Manhattan Elevated Ry. track. Mr. Fisher also showed his track jack, which sets below the rail level and was illustrated in ENGINEERING NEWS of Aug. 30.

Nut locks were also shown in great variety. The devices represented included the Eureka Nut Lock, of Marshall, Tex.; the National Lock Washer, of Newark, N. J.; the Positive Nut Lock, of Jeffersonville, O.; the James Positive Nut Lock, of Syracuse, N. Y.; the Excelsior, of Schuylkill Falls, Philadelphia, and the grooved bolt of the Illinois Bolt & Nut Works, of Peoria.

In track tools, besides the exhibits already mentioned, were the jacks, drills, etc., shown by ANDREW WARREN, St. Louis, Mo., and ARTHUR L. STANFORD, of Evanston, Ill. A very novel exhibit was two steam inspection cars, one shown by the Kalamazoo R. R. Velocipe Co. and the other by the Steam Inspection Car Co., of Ionia, Mich.

The Dunham Mfg. Co. showed the Servis tie plate in both the narrow and wide styles. Also a cedar tie from the main line of the Maine Central R. R. The tie was originally 7 ins. thick and 10 ins. face. After the rail had cut in for about ¼ in. on each end, a Servis tie plate was put on one end, and the other was let alone. At the end where the tie plate was placed the cutting ceased entirely. At the other end the cutting went on until a groove was made in which the rail rested, 1¼ to 1½ ins. below the original surface of the tie. The tie was also badly checked at this end.

Exhibits of track fastenings well made by the Bush Interlocking Bolt Co. and Dilworth, Porter & Co., of Pittsburg. The Weir Frog Co., of Cincinnati, showed blue prints and photographs of frog and switch work. Models of the Roger Ballast Car and of the Bush Surface Cattle Guard were shown, and a full size guard was shown by the Natural Iron Surface Guard Co., of Chicago.

The Giant Rail Splice, of South Bend, Ind.; the Weber Rail Joint, of New York City; the Cloud double angle girder joint.

Among the other exhibitors were the Carlisle Mfg. Co., Carlisle, Pa.; The Berry Signal Lock and Target Co., of Chester, S. C.; B. E. Tilden & Co., of Cleveland, O.; The Morden Frog and Crossing Works, of Chicago; The Indianapolis Frog and Switch Co.; and the A. J. McDonald Mfg Co. The last named company showed one of their automatic crossing gates in operation.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

Published Weekly at Tribune Building, New York.

Vol. XXIV. Saturday, September 13, 1890.

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COMING TECHNICAL MEETINGS.

Roadmasters' Association of America.—Eighth annual meeting at Detroit, Mich., beginning Sept. 9.

Western Railway Club.—Next meeting, Sept. 16. Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery, Bldg.

Engineers' Society of Western Pennsylvania.—Next meeting, Sept. 16. Secy., S. M. Wickersham, Pittsburg, Pa.

Engineers' Club of St. Louis.—Next meeting, Sept. 17. Secy., W. H. Bryan, 30 South 7th St.

Boston Society of Civil Engineers. Next meeting, Sept. 17. Secy., S. E. Tinkham.

American Society of Civil Engineers.—Next meeting, Sept. 17. Secy., John Bogart, 127 E. 23d St., New York.

New York Railway Club.—Next meeting, Sept. 18. Rooms, 113 Liberty St.

Engineers' Club of Cincinnati.—Next meeting, Sept. 18. Secy., J. F. Wilson.

Engineers' Club of Philadelphia.—Next meeting, Sept. 20. Secy., Howard Murphy, 1122 Girard St.

Association of Civil Engineers of Dallas.—Next meeting, Oct. 3, Secy., E. E. Smoot, Elm and Austin Sts.

Civil Engineers' Society of St. Paul.—Next meeting, Oct. 6. Secy., G. L. Wilson.

Western Society of Engineers.—Next meeting, Oct. 7. Secy., J. W. Weston, 280 La Salle St., Chicago.

Civil Engineers' Association of Kansas.—Next meeting, Oct. 8. Secy., J. C. Herring, Wichita, Kan.

Engineering Association of the Southwest.—Next meeting, Oct. 9. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Civil Engineers' Club of Cleveland.—Next meeting, Oct. 14. Secy., C. O. Palmer, 23 Cedar Ave.

American Society of Railway Superintendents.—Annual meeting at New York on the day preceding the fall meeting of the General Time Convention. Secy., C. A. Hammond, 350 Atlantic Ave., Boston, Mass.

A CORRESPONDENT, who is also a subscriber, sends us the following series of conundrums, in which we italicize two words:

> Will you kindly, *by letter*, advise me what the formula is for preparing the artificial stone pavements? I should like also to know if there are different varieties, with respect to excellence, durability, etc., etc. When crushed granite is employed is the composition the same with the exception that limestone is employed? What limestones make the best artificial pavement, and will the Oolitic limestone make a good one? Are these pavements under a patent? Also give, if possible, cost of this pavement. By furnishing me this information you will greatly oblige.

We are always pleased to put queries of this kind, relating to matters of general interest, into our Notes and Queries column, but the least consideration will show that it is wholly unreasonable to expect us to reply to such queries by personal letters, and we can in no case undertake to do so, except where the propounder of the conundrums has some special claims upon us for reply, or under other special circumstances. We can say here and now, however, that there are dozens of different artificial stone pavements, good, bad and indifferent, and that the selection from among them of those which are best suited for particular uses is a difficult one, even with the aid of a back file of ENGINEERING NEWS, where much information in regard to all of them will be found embalmed. To look it all up, is quite a serious undertaking, which we must respectfully decline. With every wish to oblige, correspondents should have their own files, or obtain the desired information from the various manufacturers or from books of reference.

THE life of an engineering officer in the British navy cannot be a very happy one, or certainly not a very luxurious one, if we may judge from a long article which appears in the last issue of *The Engineer*. Their pay, like that of all other officers in the British service, appears to be reckoned by the day and not the year, as with us, and begins at the munificent rate of $1.46 per day for Assistant Engineers, the corresponding pay in our service being $1,700 per year, or nearly $5 per day, including Sundays, which we assume to be included with other days in British naval pay. The pay of line officers also is extremely low in the British service, it should be noted, being for a Captain only $5.47 per day, against $4,500 per year in our service. The corresponding grades and rates of full sea pay per day for line and staff range as follows:

Age.	Engineering staff.		Line officers.	
21-27	Asst. Engin'r.	$1.46 to $1.82	Sub-Lieut.	$1.26 to $2.43
27-33	Engineer.....	2.19 to 2.43	Lieutenant.	2.43 to 2.92
33-36	" (after 6 years).....	2.67	" (after 8 years)...	2.92 to 3.40
36-40	Chief Engine'r	3.40 to 3.65	Commander	4.86
40-44	Staff Engine'r	3.89 to 4.13	Captain.....	5.47
44-55	Fleet Engine'r	4.13 to 5.35	"	5.47 to 8.00

Commanders of ships, of whatever grade, have a further allowance, called "command money," ranging from $225 to $1,600 per year. The Engineer, if not promoted to Chief Engineer before the age of 45, can retire on the generous allowance of $729 per year, or at 50 on $850 per year; whereas the Lieutenant, if not promoted to Commander, can retire at 45 on $1,458 per year.

In our own service the Assistant Engineer receives from $1,700 to $1,900 per year; the Passed Assistant Engineer, from $2,000 to $2,700; the Chief Engineer, from $2,800 to $4,200, and the Fleet Engineer, $4,400, the assimilated rank being about the same as in the British service, and retiring pay at 62, or after 30 years' service, being three-quarters of full pay. We can understand how the line pay may be very low without reflection on the British service if the navy, like the army, is organized on the theory that the officer has private means to live on; but the position of an engineer officer in naval service is quite an onerous one, and after making all allowances for differences in customary civil pay, it would seem as if the engineering staff of the British navy must be filled with plenty of poor material, or it could not be filled at all at such beggarly rates.

IT will be seen that the Fleet Engineer in the British service leaves off at the age of 55 to 60 at $1,507 to $1,953 per year, or just about where our embryo assistant of 21 begins. That there is no great expectation of any material change is indicated by the fact that all that is now even asked seem to us very trifling advances, viz:

Assistant Engineer on entering,	$1.82,	in place of	$1.46
" " after 1 yr.'s serv.,	2.19,	"	1.82
Engineer on promotion,	2.43,	"	2.19
" after 4 yrs. (instead of 6 yrs.),	2.90,	"	2.67
" " 8 yrs.,	3.40,	"	2.67

For the grades above Chief Engineer a shilling or two a day advance only is asked up to Fleet Engineers, who are to get some 10 shillings advance up to an equality with the line pay. As a whole, the pay of both engineer and line officers is much less than half that of our navy, hardly more than a third in the lower grades; making it seem to an American, at least, quite impossible that the British officer who has no private means should live on his pay as well as "an officer and a gentleman" should be expected to live. The lot of the married officers, especially, should be a hard one. Doubtless there are incidental advantages in the British as in the American service to make a given income go farther than in civil life; but there is no foreman of a third class machine shop in the United States, and we should fancy few in England, who are not paid as well as a Fleet Engineer in the British service, while every good mechanic under him will receive as much as a British Chief Engineer. This question becomes highly important when it is remembered that in the next naval war technical skill rather than bullheaded bravery will be the great desideratum. There are 120 engines, and 120 men to work them, on the Nile or Trafalgar; a high grade of technical skill is needed to keep them in order. In seeking for it the Navy competes directly with civil life, as it does not in the line, and if the British service does not recognize this difference in time it will be surprising if the next naval war does not bring them some unpleasant revelations. "Poor pay, poor preach" is an all but universal rule; and it is a pretty safe wager that the $4,000 man will show more brains than the $4 a day man in every emergency.

THE annual meeting of the American Roadmasters' Association at Detroit this week, of which a full report appears elsewhere, did only one thing of considerable technical importance. The committee on track joints has selected five of the most promising new joints, which are now competing or trying to compete with the angle bar, and has recommended them to the Association for a test in actual service upon a number of different roads, the test to be made under direction of the executive committee of the Association. If the right men are selected to conduct these tests and they are carefully carried out for the many months necessary in order that the results may be of value, we may gain some valuable information on the joint question.

The only topic which the convention discussed at all thoroughly was the best method of instructing section laborers to fit them for section foremen, and most of the discussion on this was profitless. A good share of the time of the meeting was taken up in disputing over points of order until the meeting resembled a filibustering legislature more than a technical convention. The obstructionists, with all their well-meant endeavor to have business done in a proper manner, would do well to remember that "rules of order" are made to facilitate, not obstruct, business; and that it is better to have an interesting discussion on question not quite pertinent to the set topic for discussion than to spend the time wrangling over points of order. The discussions of a technical association are not to be governed by the strict rules of parliamentary practice. With the large attendance upon these conventions and the many able men who are members of the Association the technical work done ought to be raised to a much higher standard.

Fig: 2.

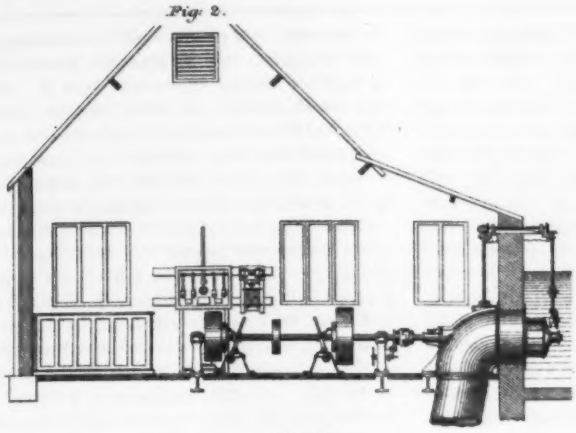


Fig: 2a

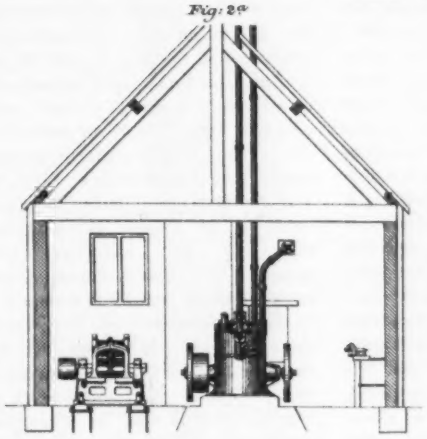


Fig: 3

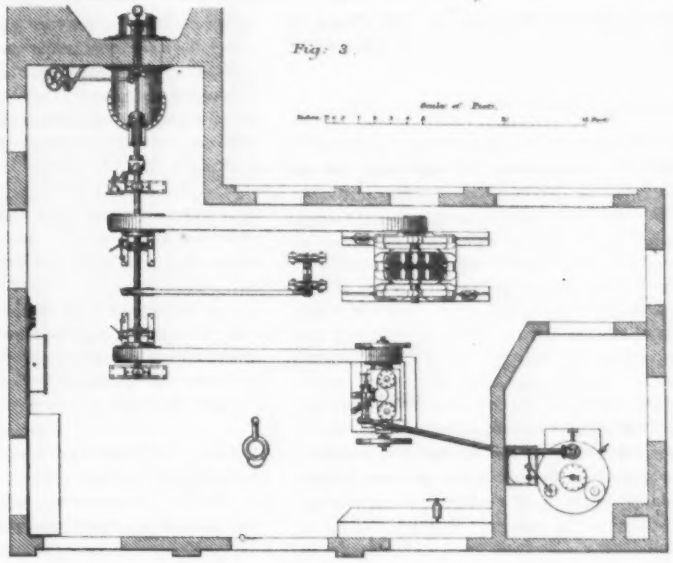


Fig: 3a

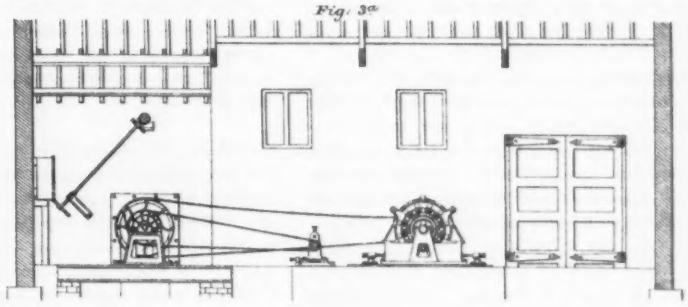


Fig: 1.

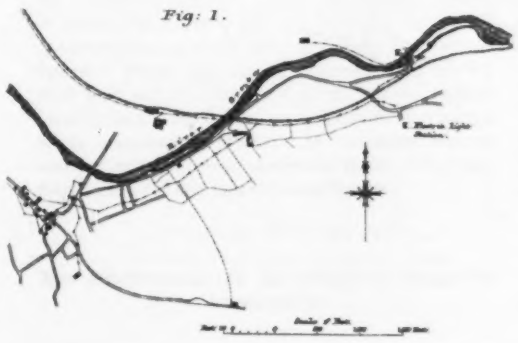


Fig: 4.

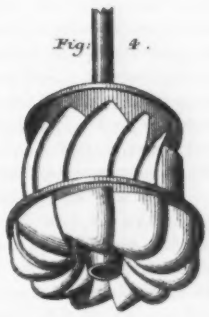


Fig: 5.

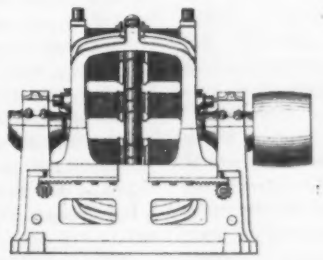


Fig: 5a

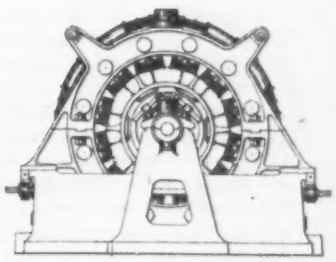


Fig: 7.

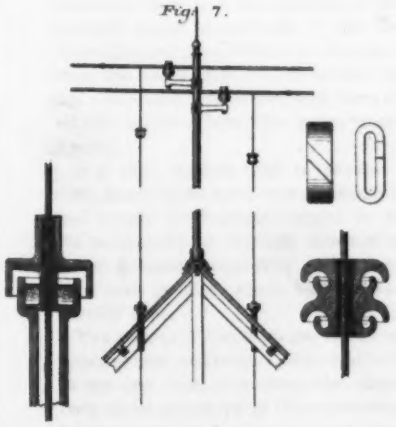
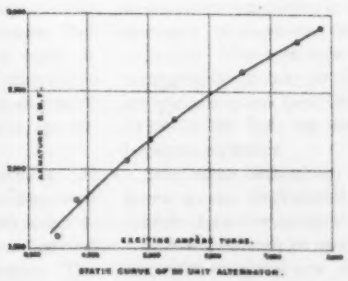


Fig: 6.



STATIC CURVE OF 50 UNIT ALTERNATOR.

Fig: 8.

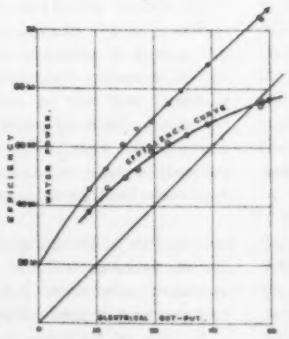
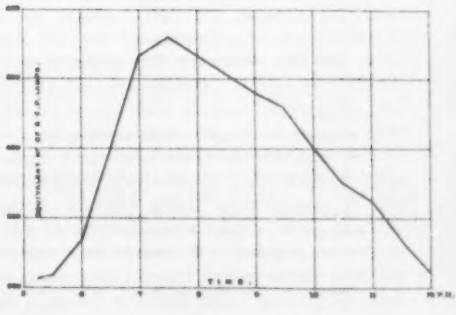


Fig: 9.



WATER-POWER ELECTRIC LIGHT STATION

AT

KESWICK, ENGLAND.

CHAS. HART & SONS, LITH., 99 VESEY ST., N.Y.

THE population of New York City, according to the preliminary estimate of the census, is only 1,513,501. A very loud outcry has since arisen at such small figures, from the Health Board and others, it being claimed that from 100,000 to 200,000 have been omitted altogether, and there have been official demands for a recount which the superintendent of the census persistently refuses to listen to, presumably on the ground of evidence satisfactory to himself that the census was substantially accurate. We do not say that these complaints are not justified. It is entirely possible that the true population of so-called city of New York (as distinguished from the metropolis, which includes Brooklyn, Staten Island, part of Westchester Co., and the Jersey towns) is as great as is claimed. But we do say that computations based upon the past ratio of growth of population within the city limits of New York, are entirely delusive, for the reason that the room for housing further population is so nearly exhausted on Manhattan Island; and we would remind our readers that in a series of articles on "The Past and Future of New York" running through our successive issues of this journal, beginning April 28, 1888, or more than a year before the census began to be taken, we predicted precisely the census result almost to a thousand of total population, in the face of many current estimates which were running much higher. We then predicted, as the result of a careful computation of the decennial growth of population since 1790, and of the population per acre of the various wards of New York, London, Paris, and other great cities, that, while the population of the *metropolis* of New York would continue to grow indefinitely and rapidly, the largest population which ever would or could be on Manhattan Island, under existing conditions, would never exceed 1,833,000, and that in 1890 it could hardly exceed 1,400,000. Add to this 113,000 for the "annexed district" across the Harlem River (it had 41,626 in 1880, and has probably increased to about that), and we have precisely the census figures. When the census returns are all out for New York and vicinity we shall review this matter more in detail, as it has an important bearing on many engineering works. In the meantime we merely intimate our doubts of there being any foundation for the current complaints.

The Performance of the Baldwin Compound Locomotive.

We give up considerable space in this and our preceding issue to a full abstract of Mr. GEORGE H. BARRUS' report of the tests of the Baldwin Compound Locomotive, which is of great interest, both from the results obtained from this novel type of the compound locomotive and from the care with which, on the whole, the experiments were conducted.

It is true indeed, that in several respects the tests might have been more accurately made. The fuel supply, for instance, ought to have been of the same grade of dry coal throughout the tests; but in general locomotive tests carried out with such care as this made by Mr. BARRUS, are extremely rare.

The results of the tests are rather surprising It appears that while the compound locomotive used 15 per cent. less fuel than the standard engine, only about one-third of this economy was gained by the more economical use of the steam. The principal gain seems to have been due to the fact that the exhaust from the compound engine did not tear the fire as did the exhaust from the standard engine. This is rather disappointing. If only a little over 5 per cent. is the extent of the advantage to be gained in the locomotive by expanding the steam through two cylinders instead of one, there is little temptation to undertake the work of bringing the compound locomotive into general service. It may now be regarded as quite certain that two or three times this economy can be obtained. As Mr. BARRUS' report plainly shows, however, in the tests where the compound locomotive was compared with the standard it was working under unfavorable conditions. In the first place, the exhaust nozzle of the compound was too small, so that not only was there considerable back pressure, but the draft was stronger than was necessary; more steam was made than was needed, and the fire-box door was open a good part of the time. But the point on which Mr. BARRUS lays more stress is that, according to the indicator diagrams, the passages from the high pressure to the low pressure cylinders were too contracted, thus throttling the steam in the ports and causing a marked falling off in the efficiency of the low pressure cylinder.

Of course at low speeds the contracted passages were ample for the steam, hence the excellent diagrams given by the low-pressure cylinder at speeds below 25 miles per hour, as shown elsewhere. Hence also the high record, made by the engine on this run, of 19.4 lbs. of steam at 135 lbs. boiler pressure per indicated horse power, which is an extremely economical use of steam, which has rarely if ever been surpassed in any locomotive tests, and never equalled, we believe, in non-compounds.

For low speeds, as in local passenger or in freight service, therefore, Mr. BARRUS estimates the fuel consumption of this engine as at least 30 per cent. less than that of a similar standard engine He points out, also, that the present engine can be easily improved by the enlargement of the passages which conduct the steam from the high-pressure cylinder to the low pressure.

In our issue of May 3, in describing the Baldwin compound locomotive, reference was made to the chances for the steam being throttled by the valve in its passage into the cylinders; and it was suggested that lengthening the port openings might obviate this. At first glance this seems needless. The total length of port opening is already 19 ins., and this is very long for an engine of this size.

But on a little examination it is not difficult to see why the exhaust of the high pressure cylinder is throttled in the ports. By reference to our issue of May 3, where the construction of the valve is fully shown, it will be seen that the steam ports of the cylindrical valve are not a single opening, as in a plain slide valve engine, but a series of 19 holes around the circumference of the valve bushing, each 1 in. long, measured circumferentially. Evidently then, the friction of the steam against the side walls of these 19 parts will cause the flow to be less with a given opening of the valve than through a single opening of an area equal to the sum of the areas of the small ports. Still with steam of boiler pressure passing into the high pressure cylinder the throttling proves to be small, except at very high speeds. It is a different matter, however, when it comes to taking the steam after expansion in the high pressure cylinder back through the valve to the low pressure cylinder. The field now has a pressure above the atmospheric of only 70 to 80 lbs., and the amount escaping is much less than at the higher pressure of 130 to 150 lbs., at which it entered the high pressure cylinder.

The same reasoning applies with still greater force to the movement of the exhaust steam, which of course escapes at a much lower pressure.

It may, indeed, be possible that the steam passages themselves are too contracted; but it is hardly probable. At any rate it seems an easy matter to lengthen the ports 3 ins. or more, as suggested in our previous article, either by cutting longer holes in the valve bushing or by making the valve of larger diameter. As the valve as now constructed seems to give no trouble from leakage, it is difficult to see any objection to this plan. The advantages secured by this novel type of valve are such that it ought not to be discarded as inefficient for high-speed engines without a further trial.

The Demand for Good Draftsmen.

Draughtsmen worthy of the name seem to be a very scarce commodity in the engineering market just now, if the frequent applications of employers to this office can be taken as an index of the trouble they have in finding men to suit them. One bridge engineer said recently that out of eighty odd answers to an advertisement for a bridge draughtsman he did not find one that was worth employing. Even a satisfactory "tracer" is not easy to discover, as we know from our own experience. The trouble seems to be that too many so-called draughtsmen think that the art begins and ends in handling a drawing-pen and in inking-in a pencil plan practically made by some one else. They are exceedingly limited in their knowledge of mechanics, and know little or nothing of structural details; in other words, they are neither well trained nor thorough in their work, and cannot be left to their own resources for a moment.

There was a time when imported German labor of this class met all demands, and usually met it well; but for some reason that we cannot explain the supply has lately fallen off, and the more valuable men already here are secure in permanent employ. The German technical schools devote much time to the thorough teaching of drawing as an essential adjunct of mechanical and civil engineering, and as a rule devote nearer twelve than four years to the careful training of pupils fitting themselves for these professions. While we would not encourage young men to adopt the drudgery of draughting for a life occupation, it is nevertheless one of the best schools for the mechanical engineer that can be chosen; provided that he goes at this work well trained in the principles and fundamental laws of mechanics, and always works with the combined purpose of making a good machine as well as a good drawing. The same remark applies to bridge draughtsmen and to those engaged in the design of metallic structures of all kinds.

In the time now allotted to "scientific training" in the majority of our technical schools, probably all the time devoted to draughting is such that can be safely spared from other work. But in too many of our schools a little less time devoted to pure mathematics, depending practically upon a retentive memory for any future usefulness and more time devoted to fundamental laws and to the training of the eye, the hand and the mind combined, would result in a graduate more useful than is usually the case to himself and to his employers. The young man leaving his school must necessarily be an assistant until he has had time to gather that worldly wisdom and experience that will alone fit him to successfully enact the rôle of a creator or leader. But the better and more thorough the previous training of the graduate, the better assistant will he make and the more rapid will be his advancement. It pays the student, therefore, to devote more time to his training, and pays in a proportion that altogether exceeds that of the extra years involved in thistraining.

Notwithstanding certain prejudices against this occupation, a really good draughtsman in the office of a bridge works or a machine shop, one who thoroughly understands his business in all its details, commands a much better salary than the average engineer on a railroad. And if he is an exceptionally experienced and good man, with individual push well developed, more doors are probably open to his substantial advance than is the case with an equally good man on railroad work. In any event, at the present time there is an army of idle men who call themselves draughtsmen and will work for $60 to $75 per month, while the really well-paid higher positions go begging for the lack of some one fitted to fill them.

CORRESPONDENCE.

Diagram of Hydraulic Formulas—Correction.

PHILADELPHIA, Sept. 6, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I highly appreciate, of course, the complimentary references to our Kutter translation, contained in your remarks upon Mr. FITZGERALD'S diagrams of hydraulic formulas in the ENGINEERING NEWS of this date; but it does seem too bad that the diagram should credit "Trautwine" with the classical weir formula of Mr. FRANCIS:

$$Q = 3.33\ l\ H^{\frac{3}{2}}$$

It is certainly not from any neglect on our part to give due credit for it, unless it is that the acknowledgment is at the foot of one page and the formula at the beginning of the next one. But Mr. FITZGERALD surely knows the Francis formula by name. It must be a lithographic error.

There seems to be something wrong about the formula itself, as it appears on the diagram. What does $(l = 1)$ in

$$Q = 3.33\ (l = 1)\ H^{\frac{3}{2}}$$ mean?

Yours truly, JOHN C. TRAUTWINE, JR.

[We simply reproduced the diagram as we found it. We recognize at once, as Mr. FITZGERALD will doubtless also, that the weir formula should have been credited to Mr. FRANCIS. Our correspondent's closing query will answer itself in the form in which we have reproduced it, viz., that the diagram was constructed for a length of weir = 1 ft. In the gothic type used for the diagram, however, the *l* and 1 look much alike, so that there is some excuse for reading the equation as $(1 = 1)$. By looking closely, however, there is an easily discoverable difference.—ED. ENG. NEWS.]

Technical Schools and the Am. Soc. C. E.

BRIDGEWATER, N. S., Aug. 18, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

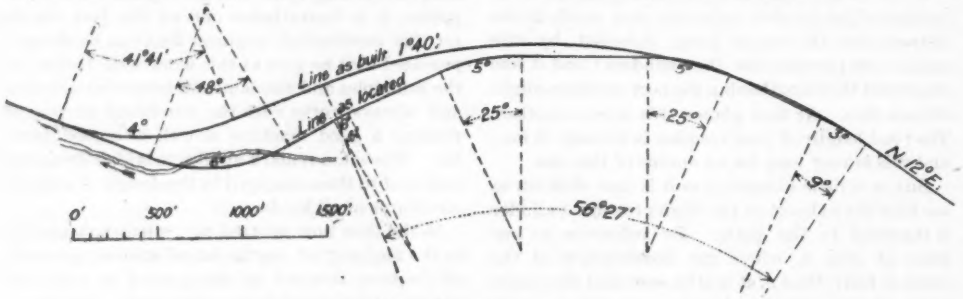
DEAR SIR: I have noticed with pleasure and fully concurred in the strictures you have passed on scientific institutions which pretend to confer the degree of C. E. As well might they assume to confer the degree of LL.D. at graduation. There is another matter that I would like to see the attention of the profession called to, and that is, what seems to me must be the low grade of requirement for admission to the American Society of Civil Engineers. I am not a member, but I know men who are, and who, judging from their work, must be ignorant of the first principles of engineering. In proof of this statement I inclose a hastily made tracing of a short bit of the line of this railway, showing the line as it was located and cleared ready for grading when I took the work, and also the line as I relocated and built it. This location (if you can dignify it by that name) was made in a level valley, from 200 to 400 ft. wide, and the relocation did not change the quantity of the grading by 500 yds. This is a fair sample of the alignment as I found it, and unfortunately most of the grading was done and could not well be changed, though we have spent money enough in changes to have made a good alignment had it been applied in the first instance.

There are many instances along this line where a sharp curve, and in some places two or three of them, were used to avoid some little hill, and afterward the whole hill, or a great part of it, was borrowed in constructing.

Now, the man who was chief engineer and the man who made the location, are members of the Am. Soc. C. E. When a man applies for admission to the society, or to be passed from one grade to another, would it not be better to examine the man's work rather than the man, and would not membership acquired in this way be of more value to the man, the society and the profession than any diploma or certificate that he has performed a certain amount of work, perhaps of the kind shown by this tracing and described in this letter? C. O. FOSS.

[The error shown in the bit of location herewith reproduced is a very common one, of a kind which naturally results from the fact that as soon as a man begins to know something about location he no longer finds it profitable to practice it. Few living men who have ever done any location have not at times been guilty of errors nearly as bad as this and hence, if men were to be excluded from the American Society of Civil Engineers, or the Institution of Civil Engineers, for having committed such errors, there would be few or none in either body who had ever done any location.

We do not speak of what should be, but of what is, and we may add that the engineering societies are compelled to act on the same basis. They cannot make inquisition into the real qualifications of candidates, but only into the fact of whether they have held positions implying competency. To even attempt to do otherwise would lead to endless trouble and unfairness. Consequently all that admission to any such body can ever imply, which is a good deal, is the negative fact that the candidate has been weighed in the balance for a certain length of time and has not as yet been found wanting. We have seen many far worse examples of location than this, which looks as if it saved a great deal more curvature than it does. Its main fault, of course, is the breaking up of the curvature into so many different curves, which was senseless, and far more injurious than the mere differences in central angle would indicate.—ED. ENG. NEWS.]



A BIT OF LOCATION.

Cooper's Specifications.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: "Oh that mine adversary had written a book" would indicate that authors suffered even in the days of JOB. Your correspondent is also suffering from having written a book or books of specifications. The very general use of these specifications has given the author a certain amount of gratification, but not remuneration, and entailed upon him an onerous expenditure of time, paper and postage stamps in trying to answer courteously inquiries as to the interpretation of clauses which he feels are perfectly clear and definite.

As a sample, numerous correspondents wanted to know whether, when the specifications say that the web plate of a plate girder must not be estimated as doing any flange action but as solely resisting the web or shearing strains, they did not mean something entirely different. Some were even so kind as to send me written treatises on the elongation of the fibres of the web by bending of the girders, assuming that after 35 years in my profession this very elementary statement had escaped my attention.

Again, my specifications give only two formulas for compression members, one for chord segments and one for "all posts." I am constantly asked (have had three inquiries in one day) whether the inclined end post is to be proportioned as a post or chord member. Now, I fail to see any uncertain meaning to these clauses of the specifications, and there would be no doubt in the minds of the inquirers if they would remember that specification clauses are not statements of theory but instruction for practice. Unfortunately a recent and excellent work on framed structures (DUBOIS), in making annotations upon my specifications has added to the confusion by failing to give correct explanations of several important clauses, the above two among others.

The influences which operated upon my mind to restrict the web plates solely to shearing strains were as follows: 1. The web is very generally spliced and not infrequently at the center of the girder and very frequently only sufficient to take up the shear. Now, a spliced web, even fully spliced, cannot fulfil the fibre strain theory. 2. In an unspliced web we do not know the exact effect of the combined shearing and bending strains. 3. We do know that a thin plate is not the best form to do a proportional duty to that performed by the heavier flanges. 4. The theoretical value of a web is proportionately greater in the shorter girders and so is the very uncertain impact strains of a rolling load. Why not, therefore, throw this uncertain flange action of the web as an additional sop to the impact?

Now as to the compression formulas: Those who have studied the resistance given by our full sized compression members under tests must acknowledge that within the limits of diameters used in good practice, and where the pins are proportioned in accordance with our usual rules, the difference in the resistance of posts with or without pin ends is very small when measured at the crippling point and nothing when we work inside of the elastic limit.

My two formulas are not therefore based upon the question of pin or square ends, but upon the following reason: The web members of trusses are far more likely to receive extra strains and accidental side blows. They should, therefore, be proportionally heavier. None of my correspondents have made any question in regard to the formulas, except as applying to the end post, the one part of the bridge which should be the most excessive in strength.

This reminds me of a not uncommon practice which bears upon this same subject: Many designers now insert a collision strut, running from the center of the end post to the adjacent panel point of the lower chord. This is all very well, if they would not immediately reverse the purpose of such a strut, by assuming that this has fixed the end post at the middle, and then proportion it for a column of one-half the length.

Another series of my correspondents assume that the expenditure of 25 cents for a copy of my specifications entitles them to my services as consulting engineer or referee, gratis. They state the case as interpreted by the two parties to the contract, and ask which is according to my specification.

I have always tried to answer these letters, though the rule of not answering letters of inquiry which inclosed no postage stamp would have justified my neglect of the great mass of them.

As the great majority refer to the two cases of the web plate and column formulæ, I hope that this communication will be sufficient answer to all such in the future, and that those who desire my services as referee or consulting engineer will bear in mind that I am also a professional brother, earning my living by charging for my services. THEODORE COOPER.

State Ownership of Railways.

PHILADELPHIA, Aug. 30, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In to-day's NEWS you remark that "The strongest argument against State ownership of railways is to point to the splendid record of improving service of the past two decades, and ask where, among the railways under public control, like progress can be shown."

If this is indeed the strongest argument on that side, the side would seem to be in need of something better; for the argument, while it may be strong, is not fair. In estimating the relative advantages of the two systems, it credits corporate ownership with its *best* results, ignoring its failures, while State ownership is made to show *both* hands.

For instance, in ENGINEERING NEWS of Aug. 20, 1887 (well, within half of *one* decade), Prof. I. O. BAKER, describing a wreck caused by a burned trestle in Illinois, writes: "The road was wrecked by the Wabash combination. The road is in a very poor condition: the track is overgrown with weeds and grass, the ties are badly decayed, the surface and alignment of the rails is bad, the road has but little rolling stock, and the most of that is in poor condition." Here we might ask where, among the railways under public control, a like condition of affairs exists.

This suggests an important feature of state control, viz., uniformity, in excellence as well as in details of practice. Instead of a Pennsylvania Railroad, offering every known luxury of railroading on the one hand, and this melancholy ruin in Illinois on the other, State ownership would no doubt eventually give us, as it does in the post office, a fair degree of excellence all round.

It should be noted also, in estimating the strength of this "strongest" argument against State ownership, that the present management has improved its service in proportion as it has substituted the main feature of State management (viz., concentration) for the diffusion of control among a myriad of petty organizations. In other words, the more nearly private management approximates to public management in this respect, the more splendid is the record to which it can point. But while we are as yet merely in the infancy of State ownership of works, and while the State is therefore in its present semi-gelatinous condition, it seems extremely doubtful whether the advocates of State ownership will not best serve their cause by leaving the matter to that powerful evolutionary tide which is now setting in that direction, never to be reversed until we begin to revert to barbarism, rather than by seeking to hasten matters by present agitation and legislation. It is at least questionable whether the immediate results of such an innovation now or in the near future would be gratifying; and if they were otherwise, the consummation would inevitably be postponed.

A homely proverb says "Bet your small change first, or, in terms of the present subject, "For the next move, try State ownership of telegraphs and of ocean fisheries (the latter, to put an end to international

squabbles about nothing), and by thus demonstrating the merits of the principle, and training the State in the exercise of its duties, pave the way for success when the time comes."

It has been said that instead of the government of the country taking its industries, the industries should take the government. The proper (and probable!) course would seem to be that both should naturally, gradually (in fact, almost imperceptibly) continue to assimilate and merge into each other, and thus become in fact, as they are in theory, "of the people, by the people and for the people."

JOHN C. TRAUTWINE, JR.

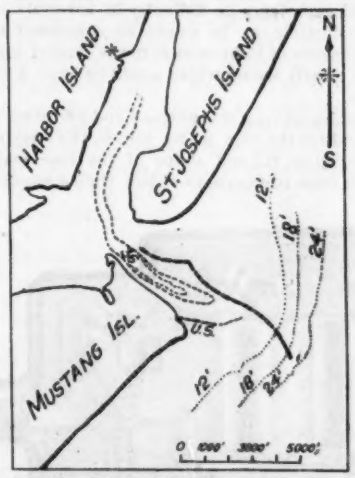
[The "splendid service" to which we alluded was merely the broad one of cheap and quick transportation with liberal accommodations, in which one privately owned railway system is conspicuously ahead of any other railway system of the world, however owned. Doubtless difference of national disposition and conditions has had more to do with this than the conditions of ownership; and, doubtless, it has been accompanied by some backwardness in improving details which under public ownership would not have been shown; but in the main the record is a truly honorable and wholly unparalleled one.—ED. ENG. NEWS.]

The Improvement of Aransas Pass, Texas.

MOUNTAIN LAKE, Va., Sept. 3, 1890.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: In ENGINEERING NEWS of Aug. 30 appeared an article under the above caption, illustrating the plans proposed by Mr. W. M. DOUGLASS for this site. The importance of securing a deep water entrance on the West Gulf coast within the territory of the United States, prior to the completion of the work at Tampico, can hardly be overestimated and several projects are being considered looking to this end. Among them may be mentioned the Outer Harbor off Padre Island, Hon. JOHN WILLETT, projector; the attempt to dredge a cut across Mustang



Plan for Deepening Aransas Pass, Tex.

Island so as to reopen Corpus Christi Bay to the waters of the Gulf, Col E. H. ROPES projector; the proposition to improve the channel at Aransas Pass by private enterprise for which a bill was passed by Congress last May through the exertions of State Senator A. W. HOUSTON, of Texas; the Brazos River jetty project, now under way, and of which E. L. CORTHELL, C. E., is Chief Engineer; the well known works by the U. S. Government at Galveston, for which an attempt was made to pass a bill of $6,200,000 for completion, which is still pending in the House, and the extensive jetties at Sabine Pass, estimated to cost of $3,000,000.

The great importance of this problem to the trans-Mississippi region constrains the writer to offer a few friendly criticisms of the plan as submitted by Mr. DOUGLASS and now made public, although known to the writer privately for some time past.

These compound jetties, while apparently novel, are similar in some features to the plan suggested and patented by J. C. GOODRIDGE, Ph. D., of New York, for the improvement of that entrance. To admit the flood tide freely, he designed a number of overlapping sea walls, arranged in echelon, and had proposed placing automatic tidal gates between their ends so as to drive all the tidal prism out between the exterior walls.

The plan submitted appears to be open to some very serious objections, viz.: The total length is almost double that of the ordinary jetties, and as indicated on the chart, aggregates 17,750 ft., or nearly 3¼ miles, while the 24-ft. curve is only about 1 mile from shore. Again, the tide would enter the apertures between the jetties and the opening at the outer end, simultaneously, during a large portion of its duration, thus causing conflicting currents and carrying with it a large quantity of sand, especially from the north side, which would settle in the channel and obstruct the passage of the ebb. The tidal volume would be diminished by the resistance offered to that portion passing into the *mouth* by the portion entering by what might be called the *gills*, and the result, it would seem, must be just the reverse of that desired, shoaling instead of deepening.

The accompanying sketch contains a suggestion for a single reaction jetty of only 7,000 ft. or less length, which it is believed will fully meet the requirements of this entrance by freely admitting the flood tide without interference, obstructing the littoral drift, defending the ebb and conserving its energy, maintaining a continuous reaction over the bar, and increasing the velocity in the channel; while it also permits of ample room for navigation. That these results are not hypothetical will appear when it is considered that the existing ebb currents maintain a channel inside the bar, having maximum depths of 36 ft., by the reaction caused in the bend, whose radius is 3,600 ft. The same radius is given to the outer concave wing of the jetty where it crosses the bar, and where the volume of the ebb will be almost as great; hence similar depths may reasonably be expected at a greatly reduced cost.

LEWIS M. HAUPT.

Automatic Block-Signaling.

It is becoming daily more apparent that within a few years some type of block-signaling will and must become the rule instead of the exception in the operation of American railways, as it is the all but universal rule in England; and it is perhaps only another sign of the difference of conditions and temperament, that the tendency in this country seems to be thoroughly in favor of some form of automatic plant, whereas in Europe the automatic type is little used, and regarded with persistent disfavor, preference being given to the original form of block-signaling, which relies upon human hands and judgment only to give the necessary signals at the successive block stations. Among the automatic block signals one of the most promising and approved is that of the Hall Signal Co., of New York and Chicago, which we illustrate this week; as showing the extent to which it has already found favor, 52 block signals are now in use on, or in progress of construction for the Boston & Albany, 80 on the New York, New Haven & Hartford (Hartford Division), 14 on the New York Central & Hudson River R. R., and the system is also being used and introduced on other leading roads. Sixty-one of this company's highway crossing signals are in use on the New York, New Haven & Hartford road, giving highly satisfactory service. The company also contracts either to sell its instruments outright; to furnish the apparatus and erect the plant complete for use; or to erect and maintain signals under a lease, the payment of rental to be conditional on the absolute fulfillment of the guarantees of service given in the contract, with conditions for subsequent purchase if desired.

The term "Block System" is applicable to any arrangement of outdoor signals and of electrical communication, by which two trains are kept a certain space, instead of time, apart. The original and still most common way of doing this, as we have stated, is to divide the line into sections varying in length from two to five miles or more on lines of thin traffic, to a mile or less when trains are frequent. An attendant at each block station keeps watch of the trains passing him, records the time of their arrival and departure, and informs the attendant at either side of him, thus permitting the rear station to safely authorize a second train to proceed over the same track. This system was introduced in England about 1853. It is now in use on over 90 per cent. of the double-track lines of that country, and within a year will doubtless be universal, as the Board of Trade, under the authority of a recent Act of Parliament, has notified the companies that the use of the system will be *required* on all passenger lines. It is now fully established by abundant experience that the block system is the only possible system of handling a heavy traffic safely; and that it is the safest of all systems for any kind of traffic. No one now disputes this, and only its cost prevents its universal use. But for the early introduction of the telegraphic train order system, which is much safer and better than the old time table system, but which never obtained a foothold in England, it is probable that the block system would be in far more general use in this country to-day than it is; but the early introduction of a slightly better system here, together with our comparatively thin traffic, prevented the early introduction here of the most perfect system, to which English practice went at one jump from the crude time schedule system.

But the original block system is not only quite expensive, from its increasing the maintenance at each block station of a signalman night and day, but it is not by any means a perfect safeguard, since it depends on the vigilance, sanity, and presence of mind of the successive signalmen, on whose actions there is no mechanical check. As the signalman, unlike the trainman and station man, has nothing else but his signals to think of, this has proved a much less serious difficulty than might have been feared in advance; in fact it has proved a comparatively small one. Still, it is a decided defect, and occasionally very serious disasters have resulted from their carelessness, as in the Meadows disaster on the Pennsylvania road, where three trains together were wrecked, four or five years ago, with heavy loss of life, because of the signalman's momentary carelessness.

Something which shall add to the block system the absolute certainty of interlocking and other mechanical plant, therefore, is an admitted desideratum, and this with the high cost of providing an intelligent attendant at every block station early led to the invention of various automatic devices to take the place of human attendants. All of these which have come into use to any considerable extent have depended primarily on electricity, though in the progress of their development pneumatic pressure and mechanical devices have been introduced as aids; and elaborate systems have even been devised, of no little seeming promise, from which electricity was wholly eliminated.

As early as 1866, Mr. THOS. S. HALL, of Connecticut, invented an electric automatic signal plant which was used on the Eastern and the New York & Harlem Railroads in 1871. A decision of the U. S. Circuit Court declared him to be "The father of the American plan of automatic electric signaling apparatus for railroads." CHAS. FRANCIS ADAMS, also, in his valuable book on "Railroad Accidents," warmly recognized his services. Mr. HALL died in 1880, but his son has since taken up the work where he left off, and perfected the plant which we illustrate.

All of the earlier automatic signals depended for communication between the block stations upon a wire strung upon poles; but as a train might break apart and leave a portion of its cars obstructing the track when it had apparently cleared the block section, and as by violation of rules the engineer of a second train might enter a section before the first had cleared it, the track circuit was proposed, and in 1880 was put in use on about 10 miles of track of the Fitchburg R.R. In this system the electric current is conducted by the rails of the track, and any metallic connection between the right hand and the left hand rail may be made to so alter the strength of an electro-magnet as to change a signal from safety to danger. The signal stands at safety as long as the current is uninterrupted, but when a pair of wheels enter the section and affords the requisite metallic connection, the greater part of the current is withdrawn from the electro-magnet holding the signal in the safety position, and it moves by the power provided (clock work or compressed air) to the danger position. This general method is now in extensive and successful use, but there are difficulties of moment connected with it, which lead many to believe that the wire system is after all the best, as is claimed by the Hall Signal Co.

In 1887, Mr. A. W. HALL, son of THOS. S. HALL, resumed experiments with the wire system as noted, and the new Hall signal has been in operation on the Boston & Albany road for two years with a most satisfactory record,* and also, for a

* "The first of these signals has been in operation about 16 months with but two known cases of stopping a train which have not been explained. In one of these it is pretty nearly certain that a switch was open at a gravel pit, around a curve out of sight, and in the other there is good reason to believe that a cross in the wires by a heavy wind momentarily occurred.

"Several other signals of this type have been in operation for a less time with almost equally good results. It is not known that a train has ever been stopped by one of these signals except for a legitimate cause. That is, a preceding train in section, a switch open, or, as in a very few cases, an accidental derangement of the wires. In one case a train was wrecked and broke down the wires. In another, a derrick guy was brought in contact with the wires. In a third case, some men were removing dead wires from some switches no longer in use. This record of efficiency is far ahead of any other system of signals with which I have had experience."—[Extract from lecture of GEO. W. BLODGETT, Electrical Engineer Boston & Albany R. R., delivered before the Massachusetts Institute of Technology, Boston, Mass, May, 1890.]

somewhat shorter time, on the New York, New Haven & Hartford RR. The company has, until lately made no effort to extend its preliminary work beyond these two roads, rightly judging that the plant must first become a demonstrated success in actual service before it could be generally introduced.

The principle on which the Hall signal is constructed and operated is that the first wheel entering a block section operates a track instrument (Fig. 4) so as to set a signal (Figs. 1, 2 and 3) at danger, and at the same time breaks an electric circuit in such a way that under no possible contingency can the signal again show safety until the train passes out of the block section and operates the track instrument which restores the circuit. This last is effected through an interlocking instrument (Fig. 6). If a wire breaks or is grounded, or two wires become crossed, the signal goes to danger. Likewise, a failure of the battery or any derangement of parts, or the occurrence of any of the mishaps which experience has shown signal connections to be liable to, must always result in setting the signal of danger. The disc assumes the danger position by gravity whenever the power exerted by the electric current is withdrawn. In other words

FIGS. 1 and 2. Signal Case

the safety position of the signal is dependent upon an uninterrupted circuit through the magnets of the signal instrument. It is simply and only the attractive power of electro-magnetism which holds the signal at safety. It falls to danger by gravity on any interruption of the electric circuit, from a lack of force to hold it in the safety position, and it can assume the safety position only when all the apparatus is in perfect order and no train has entered the section.

The essential features obtained are the employment of a closed wire circuit for each block, each provided with a battery and relay, and operated by two track instruments for opening and closing the circuit when trains enter or leave the block: with switch instruments at each switch on the block (Fig. 5) to break the circuit when the switch is thrown from main line, and with appropriate signal posts to give all necessary signals. It is claimed for the plant that it is the only block signal which embodies the essential principles of automaticity; viz., that the electric circuit holding the signal at safety shall be *opened* by the passage of a train (or the turning of a switch); that the signal shall move to danger, by the force of gravity alone, when the circuit is broken; that the signal shall move to danger, by the force of gravity alone, when the wires are either crossed or grounded. It is also claimed to be the only automatic block signal that has made a perfect record, by never failing to indicate danger immediately after the entrance of a train into the section, and to continue to thus indicate until the train passed out of the section; and that has never failed to show danger immediately on the turning of any switch in the section. It is also claimed that it has caused by far the fewest, unnecessary stops, in proportion to the number of operations, and that it is materially cheaper to erect and maintain than any other signal that has given even approximately satisfactory service.

On the other hand, it is an admitted objection to the system, that it does not directly meet the contingency of a train breaking in two on a section, and part of it remaining on it or running backward.

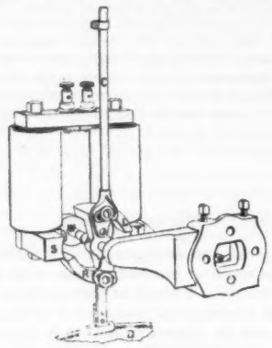


FIG. 3. SIGNAL INSTRUMENT.

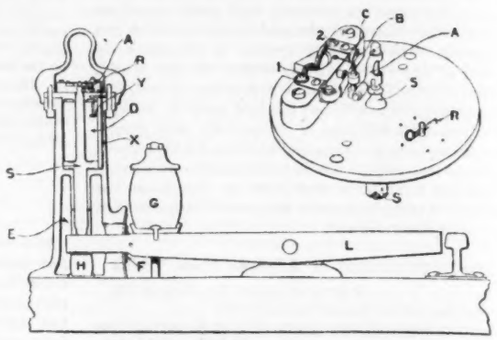


FIG. 4. TRACK INSTRUMENT.

Neither does it become inoperative if a rail breaks or is removed. But it is claimed on the other hand, that breakaways rarely happen to passenger trains; that there is a good chance of both sections being stopped on the block; that even if a rear section is stopped on a block after the front section has passed off it, the section can protect itself by a flag, and more than all else, that the introduction of automatic air brakes and couplers, which is now going on so rapidly, will practically remove all danger of this kind from trains breaking in two; which seems a well justified claim. Five years from now, unless all signs fail, few or no trains of any kind will be running without the protection of air brakes, which prevent the two sections of a train from separating or running far in case of a breakaway.

As respects broken rails, it is claimed that "a large proportion of breakages, probably nine out of ten, occur in such a way as not to interrupt the circuit, even though serious enough to derail a train, so that the ordinary methods of inspection cannot be in the least relaxed." The substance of this claim also seems to us well founded, although there must be, and has been, a residuum of cases in which rails have been removed or broken clear across so as to break the circuit, leaving the track circuit the only safeguard. No system can well combine all possible advantages, and therefore a choice must be made between sacrificing this undoubted advantage of the track circuit system and sacrificing the greater simplicity, certainty and economy claimed for the wire circuit system.

Before attempting more complete description of the plant as a whole, we describe the separate devices shown in Figs. 1 to 6, on which the working of the plant depends.

The case for the Hall signal shown in Figs. 1 and 2 is circular in form and painted dark. The background thus provided for the disc in the center is of such distinctive shape as to forcibly attract the attention of an engineer, even if he be unacquainted with the road. The efficiency of the signal as an indicator of safety depends on the contrast between the disc in the center of this case and the surface surrounding it; in other words, on the difference between the lightness of one and the darkness of the other. When the signal stands at danger the center is red and the surrounding surface dark; but it is claimed that a color-blind person, even then, would experience no difficulty in correctly reading the indication, as he would be compelled to note the absence of light (white) in the center; and only after clearly seeing white would he have a right to go on.

Besides serving this purpose and affording a background for the disc in its center, the large surface (about 10 sq. ft.) and shape of the case make it a much more conspicuous object than a semaphore of any reasonable size, while the unavoidable liability of the semaphore to derangement when unprotected from snow, ice or wind, and the considerable amount of force required to move it if of proper size, are thought to make the Hall type preferable, which has all its moving parts covered and protected from the weather, and so can be operated by such a small force that magnetic attraction alone suffices.

FIG. 5. SWITCH INSTRUMENT.

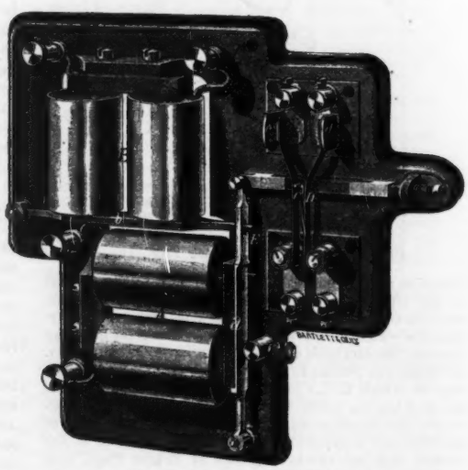


FIG. 6. INTERLOCKING INSTRUMENT.

Fig. 3 shows the mechanism which operates the signal inside of Figs. 1 and 2. The arms of the Z-shaped part marked *R* and *L* are the two wings of an armature which revolves on the shaft *W* between the prolonged cores *S* and *T* of the electro-magnet, and to which are attached the disc *D* at the bottom of the cut, and its counterweight rod *C*. The disc being heavier than its counterweight, the signal moves to danger by gravity. When the electromagnet is

energized the disc is drawn up out of sight by the rotary movement of the armature, exposing a white reflector. The disc is made of red silk stretched over a rim of aluminum 16 ins. in diameter. A distance signal is of substantially the same construction, green silk being used for red. The arm at the right of Fig. 3 is for attachment of the mechanism to the case.

Fig. 4 shows the track instrument, the larger cut showing the mechanism as a whole, the smaller cut the upper part of the instrument to enlarged scale. The lever *L*, upon being depressed by the wheels of a passing train, forces upward the piston *S*, moving in an air chamber *D*, and communicates motion to the key lever *A* (see small cut) of the circuit-closing apparatus. The upper and lower ends of the air chamber are connected with each other by a port *X*, so arranged that when the piston is forced upward a portion of the air above the piston is forced out through the opening *Y* (placed a little below the top of the cylinder) and port *X*. When the piston has risen high enough to cover the opening *Y*, as an effect of the *quasi* bow which the lever *L* receives from the wheel, the communication with the lower end of the cylinder is cut off, and the air remaining in the upper part is confined and constitutes a cushion, preventing the piston rod from being thrown forcibly up against the top cap. The piston rod extends up through the cylinder head or top plate, as shown at *S* in the small cut. Upon being actuated by the lever *L* its beveled top engages the roller of the swinging arm *A*, which forces the spring *B* to a contact with its anvil *C*, thus completing a circuit between 1 and 2, the wire connections. When the piston has been raised by the action of a passing train the air forced out by it is driven through the port *X* and enters the air chamber below the piston, so that when it falls back the air so introduced retards it in its fall, thus preventing injurious shocks. *R* is a valve for regulating this air pressure. The lower end of the piston rod moves in a closed chamber *E*, in which the end of the track lever works. This opening is closed by means of movable plates *F* fixed on the lever, and working against the edges of the opening. The lever is confined between two rubber springs *G* and *H*, which are so compressed that any weight less than that imposed by the pressure of an ordinary car wheel, as by a man or boy stepping on it, fails to operate the piston. This instrument as a whole seems a very neat device, all the parts being well protected and likely to act with certainty.

Such an absolutely reliable track instrument is an essential feature of any automatic wire-circuit signal. The instrument shown in Fig. 4 has been in use for 15 years, and some hundreds of individual instruments have withstood millions of blows. About 30 track instruments, that had been in service on the Boston & Albany in connection with old-style Hall signals for 12 years, have been retained in service (with some late improvements added) in the reconstruction of the signals of that road under the new Hall system during the present summer. A similar number on the Eastern (now Boston & Maine), put in service over 15 years ago, are said to be still in satisfactory operation; and over 2,000 of the instruments have been in operation for many months without any expenditure for repairs. It would therefore seem to be of proven efficiency, and there is considerable demand for it, irrespective of the block system, for the announcing of approaching trains at highway crossings, stations, drawbridges, switch towers, etc., on roads where no automatic block signals are employed.

For connecting switches with the block signals, which is an essential feature of the plant, the form of switch-instrument shown in Fig. 5 is employed. The displaying of the danger signal is effected by the breaking of the circuit in this instrument, which is connected in any convenient way with the switch, or may be made a part of the stand. When the switch is set for the main line, as it is in the cut, the pendulum of the switch instrument is at right angles with the rod extending to the rail and the spring above it is held in contact with its anvil. This completes the electric circuit, which holds the signal at safety. The movement of the switch from the main line throws the pendulum out from the vertical position, and the little roller at the top of it passes onto the depressed portion of the spring, allowing it to rise and break the circuit, when the signal falls to danger.

A point in favor of automatic signals as compared with the simple English block system which is well worthy of note, is that, in the latter, there is no provision, such as this instrument affords, for the protection of the switches of side tracks which are at a distance from the block signal operator. The most common provision in England is "Annett's Key," which consists in a combination of lock and key, so arranged that a conductor who wishes to use the side track must get the key from the signal man and, after using, must return it to him. But with the electric automatic system all movements of any number of switches are instantaneously indicated at the entrance of the block section, and with equal certainty, whether there be one switch or a dozen.

Fig. 6 shows the electric interlocking instrument, which consists principally of a main electromagnet *A* and its armature, and an unlocking electromagnet *B* and its armature *b*, the latter constituting a locking lever. To the armature of *A* is fastened a horizontal bar which, by means of tappets, actuates the advancing string *C* and the retreating spring *D*. When the main electromagnet is momentarily energized and its armature attracted, contact is made between advancing spring *C* and its anvil *c*, while the contact between retreating spring *D* and its anvil *d* is broken. The armature of *B* instantly drops, locking the armature of *A* and retaining the springs in this position. When *B* is momentarily energized and its armature is attracted, and not till then, the armature of *A* is unlocked and contact is made between retreating spring *D* and its anvil *d*, while the contact between advancing spring *C* and its anvil *c* is broken. Thus, when the advancing spring is open the retreating spring must be closed, and when the retreating spring is open the advancing pring must be closed. Upon this principle is based the Hall system of electric interlocking.

The instruments so far described include all those used in the Hall system, and are applied to single or double track block signaling, automatic audible highway grade crossing signals, signals for the protection of railway grade crossings, and signals for the protection of single or double track junctions. A description of the method of applying them to these several purposes we must postpone for lack of space to a following issue.

The Repair and Maintenance of Roads in England.

While it is well known that England possesses a great extent of excellent roads, there is still a wide field for their improvement in that country. To aid in this work the Roads Improvement Association, with headquarters in London, was organized a few years ago for the following purposes: (1) Circulating popular and technical road literature, having for its object the enlightenment of the rate payers upon a subject which affects their pockets and their interests; and also the guidance of county councillors, highway boards and other authorities having control of roads, and the instruction of road surveyors and the laborers under their charge as to the proper system of road repair and maintenance. (2) Remonstrating with the responsible authorities in cases where the neglected state of the road has become a public scandal, and, where necessary, as a last resource taking legal action to enforce the rights of the public. (3) Watching any suggested legislation and introducing new legislation with the view of removing anomalies that at present exist. (4) The extension of the use of guide posts and milestones, with their improvement and proper maintenance. Large numbers of pamphlets and leaflets have been distributed, and the results of this missionary work are said to have been very gratifying.

From one of the pamphlets issued by the Association, on "The Repair and Maintenance of Roads, by Mr. W. H. WHEELER, M. Inst. C. E., we make the following extracts:

Good Roads Economical.—For economical and convenient traction, roads should be maintained in thoroughly good order. This, however, is too seldom the case. Turnpike roads, which at one time were maintained in efficient condition, since they have been handed over to the parish authorities have been allowed to deteriorate to the condition of ordinary highways; and many roads are kept in such a condition as to be a disgrace. This is the more inexcusable as it is a fact, well known to all who have had experience in the matter, that roads well maintained and kept in good order cost less than bad roads. So long ago as 1819 a select committee of the House of Commons gave expression to the following opinion as the result of the evidence placed before them: "The most improved system is demonstrated to be the most economical; and even the first effectual repair of a bad road may be accomplished with little, if any, increase of expenditure, and its future preservation in good order will, under judicious management, be attended with considerable saving to the public." The author can bear practical testimony to the fact that not only do roads kept in good order cost less to maintain than roads badly repaired, but that also a direct benefit arises to the persons using them from the greater loads which horses can draw.

Management.—Under the provisions of the last Highway Act, the payment of one-half the cost of the main roads out of the county rate, and one-fourth out of the government taxes, on condition that the roads are maintained in a condition satisfactory to the county surveyor, has acted as a check on the highway authorities. Where the county surveyor has done his duty by strictly refusing the grant where the roads were not efficiently maintained, the parishes have found it to their advantage to employ more competent surveyors and to have good roads. By the Local Government Act of 1888, power is given to the county councils to take into their own hands the management of the main roads. This plan ought to lead to economy and greater efficiency. The placing of the main roads under the control and management of the county surveyor will insure the supervision of a skilled officer and a more efficient system of management.

Width of Wheels.—The following proportions have been recommended: ¼ to ¾ ton on each wheel, tire 3 ins. wide if without springs, 1 in. with springs; ¾ to 1 ton, 4 or 3 ins.; 1 to 1½ tons, 6 or 4 ins. A clause proposed to be inserted in any new Highway Act that may be passed requires that all carts weighing over 672 lbs. should have wheels of not less than 4 ins. width, and vehicles drawn by more than three horses should have wheels of not less than 6 ins. width. Wheels of a large diameter do less harm to a road than small ones. Stones will be pushed and moved out of place by the small fore wheels of a wagon, while the larger hind wheels will pass over without displacing them. Large and broad wheels not only do less harm to the roads, but cause less draught for the horses.

The Condition of a Good Road.—A perfectly good road should have a firm, dry foundation, good drainage, a hard and compact surface free from ruts, hollows or depressions. The surface neither too flat to allow water to stand, nor too convex to be inconvenient to the traffic; free from loose stones, the fresh material being put on whenever practicable in winter, in such a manner as to inconvenience the traffic as little as possible. All mud to be scraped off the surface at once and not left in heaps on the road. A grade of 1 in 40 (2.5 per cent.) may be considered as safe for a horse to trot down with a light vehicle, and this should be the limiting grade. In hilly districts it is not possible to keep the grades down to this, but there exist numerous cases where, by taking off the crest of a hill and filling the hollow, dangerous portions of roads might be improved at a comparatively small expenditure. A grade of 1 in 20 (5 per cent.) is too steep for convenient traction and should never be exceeded. Where railways alter roads for bridges or other purposes, the grade must not exceed 1 in 30 (3.3 per cent.) for a turnpike road or 1 in 20 (5 per cent.) for any other public carriage road. On a good paved road a tractive force of 33 lbs. is required to move a ton; on a well constructed and maintained macadamized road, 46 lbs.; on an ordinary country road, fairly well kept, 65 lbs.; on a badly kept road, with loose surface, the force may be double or treble the last figure.

Formation of New Roads.—TELFORD'S plan was to lay a solid pavement of large stones, on this a layer of stones carefully broken to pass through a 2½-in. ring gauge, no stone weighing more than 6 oz., and on top of this gravel or other fine material to bind the stones. Great attention was paid to the surface until it became thoroughly solidified, and then it stood for several years with very little repair. MACADAM substituted for the first coat of rough pitching a layer of hard stones broken into

angular fragments. As ruts or irregularities formed they were raked and leveled, and fresh material added until a hard and level surface was obtained. Granite, greenstone or basalt was preferred. The great art in road making is to so construct the surface that wet cannot penetrate from the top and dirt cannot work up from the bottom. The use of refuse from ash yards is to be condemned. Chalk is easily affected by frost, unless covered with a thick coating of hard material. Burnt clay is dry and porous, and if well burnt and thickly covered makes a good material.

Improvement of Existing Roads.—The mud on the surface must be regularly removed, all hollows and flat places filled with well broken, hard, angular material, and this process continued until the surface becomes level. If new material is required in summer, it should be very small, and be covered with road scrapings in order to get it bedded. Granite chippings are a useful material for patching in summer. As soon as the wet weather in autumn commences, the wheel tracks and hollow spaces, caused by the horses' feet, should be filled in with stone, put on with a shovel from a wheelbarrow; as fresh tracks are made, fresh material should be put on, and this is continued up to the end of December or the middle of January.

Best Form of Road.—Roads that are too flat hold the water and keep the surface wet. Roads that are too round are inconvenient for traffic and wear badly, owing to the sidewise slipping of the wheels and the tendency of the traffic to keep in one track along the middle of the road. The best form for the transverse section of a road is that of an ellipse, the surface having a small inclination in the middle and a steeper fall at the sides towards the gutter. A total fall from the center to the sides of ¼ to ¾ in. per ft. will be found sufficient on a road repaired with good hard material. Where soft, inferior material is used a greater inclination must be given.

Repair of Urban Roads.—Where there is much traffic it is impossible to prevent macadamized roads from wearing into dust in summer and mud in winter. In repairing the wear with broken stone, some substance must be used that will enable the stones to bind together and form an even surface. The filling material will cause dust and mud; but if not used, the stones themselves will be ground down to fill the interstices. Some road surveyors have adopted the plan of mixing the filling-in material with tar before it is placed on the coating of stone. A road treated in this way, if well rolled before being used, has a surface almost impervious to rain, and, owing to its elasticity, of a very enduring character. Granite chips or the screenings of broken slag are excellent material for mixing with the tar. The heap of material, after mixing, should be allowed to remain for several days before use, otherwise it will be too sticky. The material used in repairing is the hardest and toughest to be procured, broken to an even and regular size, the fragments not larger than will pass through a 2-in. ring. The surface is covered with sharp material of the same character as the stone, ground to chips in a stone breaker. The surface is then well watered and rolled with a steam roller weighing not more than 10 tons. A greater weight is apt to damage the gas and water pipes. Horse rollers, if sufficiently heavy, require several horses, and the tread of their hoofs has a tendency to loosen the stones and leave indents which the roller does not level. The universal testimony of surveyors who have used steam rollers is that, while making good roads, they are economical.

Repair of Country Roads.—This is a much easier task than the repair of town roads. The main points to be observed are: Constant care on the part of the roadman never to let his road get out of order; use of good material; proper attention to surface drainage; cleaning the mud off in wet weather; removing all loose dry stones in dry weather. Roads should be divided into lengths, and a certain length allotted to each man; the same man should be kept on the same portion of the road. On an ordinary main road, where good materials are used, an active man can keep from 3 to 4 miles of road in repair, with occasional help in winter to assist in putting material on. The men should be carefully selected, and should be employed all the year round. There is always plenty of work in keeping the roads clean and free from loose stones; in cutting weeds, and cleaning out water tables and drains. In dry weather by removing the dust there will be less mud to scrape off in winter. In showery weather, by filling up the low places with small stones the road is kept level and in better condition to withstand the bad weather in the ensuing winter. The practice of employing incapable old men at small wages is far from economical, and cannot be too strongly condemned. The object of the roadman should be so to manage his road that ruts are never formed; the surface should be kept level so that the water may quickly pass off. This can only be done by constant vigilance and by changing the line of traffic.

Where three ruts have been formed, one rut only should be filled at a time, so that traffic will be diverted, the wheels of some vehicles going on one side and those of others on the other side of the new material. It is best first to fill up the track made by the horses' feet, as the horses will then of themselves avoid walking on the new material. By judiciously putting the stone on in small quantities at a time, first on one part of the road and then on another, the surface is kept level and hard, the wet gets off easily and there is less tendency for ruts to form.

Mud should be regularly removed, as in winter it prevents the sun and wind from drying the road, and in summer it causes clouds of dust. No road surface can be kept hard, nor can ruts be prevented where mud is allowed to accumulate and remain on the road. The summer dust makes winter mud; and it requires much less labor to remove dust than to remove mud. Bass brushes do not displace the material as much as scrapers, and more effectually clean and dry the road. For macadamized roads where there is much traffic a horse sweeping machine is a most effectual instrument.

Loose stones should be picked off in summer time, as they are inconvenient and dangerous to horses and cyclists. The roadman on rural roads should regularly and frequently go over his road with a basket and remove any loose stones lying on the surface. If material put on, to fill up hollow places in wet weather, does not become bonded by the time dry weather sets in, the material should be removed and wheeled back to the stone heap.

Surface Drainage.—At the sides of all roads maintained in good order, a gutter or water table is formed, with an edge cut in the grass like that of a garden path, openings being left at intervals to let the water get away to the ditches. This edging defines the metalled surface of the road, and affords the means of rapidly discharging the rain falling on the surface. The edging should not be so high as to prevent the passage of wheels over it in an emergency, and should therefore not exceed, except where there is a regular footpath, 3 to 4 ins. in height. The formation with a proper water table is better for the road than the removal of the grass sides and the continuance of the transverse slope of the road to the ditch, a practice sometimes carried out with the view of affording drainage. If this grass is removed, the sides of the road became poached by cattle trampling in wet weather, and are generally dirty and wet, while the dirt is carried onto the road by the feet of sheep and cattle. The grass sides afford an abutment to the metalled part of the road, and the edging prevents the stones from being kicked into the ditches. The sides should be regularly cleaned of the mud and dirt washed down by the rain, and the water tables should be cleaned out in the autumn before the wet weather sets in. The number and position of the cross outlets to the ditches can best be determined in wet weather, the lowest places being then easily seen by the standing of the water. When the edge forms a footpath, the outlets must be provided for by pipes passing under the path. A man can properly clean out and trim 12 chains of gutter a day.

Material.—The chief requisites for a material for repairing roads are, that it should be not only hard but tough, and not easily affected by the weather. The fragments should be angular and cubical so as to bind well together; each stone should fit against and be wedged compactly up to its neighbors, as in a piece of mosaic work, and no space left for water to penetrate. It is more economical to use good material, even if it has to be brought from a distance, than inferior local stone at less cost. No material is so efficient and really economical as granite or some of the hard volcanic rocks. There is less labor and carting in putting a durable and lasting material onto roads than one that is more perishable and requires frequent renewing. Some of the harder limestones and sandstones make fairly good roads; but the former especially, although hard and tough, becomes disintegrated rapidly by frost, and both wear into dust and mud. The softer kinds of limestone are unfitted for good roads; they are soon ground into dust, which forms a sticky mud. Broken slag, which is much used, is cheap; but it is brittle, makes a slimy mud, and from its want of toughness it does not make a good wearing surface. Flint gravel makes a clean road, and if properly attended to gives a firm surface. Sea shingle, and gravel consisting of rounded pebbles, although clean and hard, never consolidate. Round gravel is one of the worst and most dangerous materials. If the gravel becomes consolidated in winter it is certain to work loose in the following summer; as the constant tendency of all stones having rounded surfaces is to roll around each other, and so work loose. The materials to be avoided are those that wear quickly and that work loose.

The stones should be of uniform size, and the hard and tough rocks should be broken into smaller fragments than those that are softer. Where granite or hard material has not long been used, the size to pass through a 2-in. gauge is not too large; after granite has been used for some time and the road has become fairly well coated with it, so as to give a good resisting surface, a size to pass through a 1½-in. gauge is sufficient. A smaller size will not stand the crushing of the wheels, and soon becomes dust.

Stone should be carted and placed in heaps during the summer, to be ready when wanted; all stones harden by exposure to the weather, so that stone so placed will wear better than if hauled direct from the quarry. If possible the stone should be placed at the side of the road in heaps of a cartload each, and wheeled onto the ground in barrows. With stone placed direct from the cart, it should be shoveled, and not shot directly out of the cart. In repairing the stone should be laid in the early part of the winter, to allow of its being thoroughly bedded and incorporated with the old material. If necessary to put stone on at other times, the surface should be loosened with the pick, the stone evenly spread and covered with clean road scrapings For repairs of this kind only the smallest kind of material, such as granite chips, should be used.

Cost of Repairing Roads.—The cost must necessarily vary with the amount of traffic and the ease with which materials can be supplied. The average of the turnpikes and main roads in England and Wales, for manual labor, materials, carting, tradesmens' bills and salaries, for the years 1881-82-83, was $168.15 per mile, and for ordinary highways, $59.30. The great difference between the two is accounted for partly by the fact that on many highways there is no traffic except that due to the use of the roads by persons living in the locality, but chiefly because under the head of highways are included many miles of roads which are little else than green lanes, only used in the tillage of the fields to which they give access. It may be taken as a fair estimate for the main roads, excluding the strictly urban portions, that a mile of road will require 40 tons of granite to repair it, and that one man can keep in order 4 miles of road. Putting the granite at $2.50 per ton, and the wages at 62½ cts. per day, this, with an allowance for carting, extra labor, and incidental expenses, would give about $175 per mile per year. After a road has been thoroughly well coated with granite, the quantity of material required will decrease considerably. On the other hand, roads which have previously been repaired with soft and inferior material require a larger quantity of material and more labor.

A NEW METHOD OF FIRING HIGH EXPLOSIVES has been invented by Mr. L. GATHMAN, of Chicago, Ill. The inventor claims that by his method an 8-in. gun can throw a shell containing 100 lbs. of any high explosive to a distance of three or four miles The Ordnance Board of the United States army will investigate the method shortly.

ARID LANDS BELONGING TO THE NATIONAL GOVERNNMENT are again open to sale and settlement, with the exception of such as have been reserved for reservoir sites. This is the result of the

repeal on Aug. 30 of the act of Oct. 2, 1888, by which Congress withdrew all arid lands from settlement.

A GREAT LUMBER FLUME with a daily carrying capacity of 250,000 ft. has just been completed at Sanger, Cal., by Moore & Smith. With branches it has a total length of about 60 miles.

A FORTY-INCH OBJECTIVE is being made for the University of California according to M. CAMILLE FLAMMARION. This lens, which will be the largest in the world, will be mounted at the Mt. Wilson Observatory, near Los Angeles, Cal., and will be strong enough to show stars of the seventeenth magnitude.

A DESIGN FOR THE GRANT MONUMENT has been selected. The competing architects were CARRERE & HASTINGS, C. W. CLINTON, N. LE BRUN & SONS, J. H. DUNCAN AND JOHN ORD. Mr. DUNCAN'S plans have been adopted. The monument will be 100 ft. square, exclusive of porticoes and steps, and 165 or 170 ft. high. The monument is said to resemble the tomb of Napoleon at Paris.

A SITE FOR THE WORLD'S FAIR has been at last agreed upon. The Directors adopted the dual plan on Sept. 9, and as the Federal Commissioners are probably in favor of the two sites, the question can now be considered settled. The Lake Front part of the land selected is a long grass-covered common on the shore of Lake Michigan and borders the business center of Chicago. It contains now about 90 acres, but will be increased by piling and filling a number of acres of submerged land, and bridging over the Illinois Central tracks. Jackson Park, the second part of the site, has about 150 acres of improved and 400 acres of unimproved land. The two sites are to be connected by rail and steamer so that but a few minutes will be necessary to pass from one locality to the other. Lake Front will contain the main entrance to the fair and the art buildings, while Jackson Park will be devoted to agricultural and mechanical exhibits.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Philadelphia & Seashore.—Work which was stopped some time ago has been resumed on this New Jersey line and it will soon be completed.

Lehigh Valley.—The Easton & Northern Railway Co. now constructing a line from Ashland, Northampton Co., Pa., to serve as a branch road of the Lehigh Valley R. R. will probably abandon its attempt to make Easton its connecting point with the Lehigh. Several routes have been surveyed through Easton, but none of them is satisfactory, and any one would be very expensive. The road is already completed nearly to Easton, but has come in contact with several properties just outside of the city whose owners demand exorbitant prices for right of way. The company is considering the plan of following Bushkill Creek on the north side to the Delaware, connecting with the Belvidere Delaware R. R., and extending through Phillipsburg, N. J., to connect with the Lehigh Valley.

Shenandoah Valley.—The plan for the reorganization of this company has been decided upon. The road is to be sold at foreclosure on Sept. 30 to a committee of the first-mortgage bondholders. A press dispatch says:

The plan contemplates the issue of $10,000,000 of fifty-year 5% mortgage bonds, $4,500,000 of preferred stock, and $2,500,000 of common stock. The preferred and common stock are to be transferred to the Norfolk & Western R. R. in consideration of certain guarantees. The holders of present Shenandoah Valley first-mortgage 7% bonds will receive par and full interest in new mortgage bonds, being at the rate of $1,420 a bond. The holders of the Shenandoah Valley general mortgage bonds pay an assessment of $65 a $1,000 bond and receive $1,100 in Norfolk & Western preferred stock. The new bonds are to be guaranteed by the Norfolk & Western R. R. Of the $10,000,000 authorized, $3,223,400 will be issued in taking up the present first-mortgage bonds, $4,276,000 will be used in paying off receiver's certificates, car-trust obligations, for costs of reorganization, for double tracking and improvements and equipment, and the remaining $2,500,000 will be spent in securing a terminus in Washington, D. C., and in the construction of a road from Front Royal to that city.

Baltimore & Eastern Shore.—This Maryland road has been completed and is now in operation from Baltimore to Ocean City, Md.

Dutchess County.—Work on this road is progressing favorably and is now about one-half completed. The company has finished a survey for an extension from Hopewell junction to the New York & Northern R. R. D. N. Stanton, of Yonkers, N. Y., is a director.

Wellsville, Coudersport & Pine Creek.—About one-half of this railway from Coudersport, Pa., to Wellsville, N. Y., 28 miles, has been completed.

Confluence & Oakland.—Engineers are at work locating an extension of this road from Friendsville to Oakland, Md.

Baltimore & Ohio.—Mr. Thomas M. King, Second Vice-President of the Baltimore & Ohio R. R. Co., who has charge of the construction of the Baltimore Belt R. R., has awarded the contracts for the work. Sections 1, 2 and 4 were awarded to Ryan & McDonald, and Section 3 to McCabe Bros. The contractors are Baltimore firms. The first section is 2 miles long, and extends from Bay View Junction to the Belair road; the second section is 1¼ miles long, and is from Belair road to Guilford Ave.; the third section is 1¼ miles, and is from Guilford Ave. to a point near Mount Royal Ave., and the fourth section is from Mount Royal Ave. to Hamburg St. Section 3 is required to be tunneled under Maryland Ave., Charles and Calvert Sts., and Section 4 includes the tunnel under Howard St. The bids of the contractors call for an outlay of $3,000,000 for the work. Ryan & McDonald will begin operations on a portion of the work in a day or two. The entire construction is to be under the supervision of Mr. Samuel Rea, Chief Engineer of the Belt Co., and all work and material is to be subject to his approval. A detailed description of the work will be found in our issue of June 28.

Projects and Surveys.

Lancaster, Oxford & Southern.—Organized in Pennsylvania to build a railway from Quarryville, Pa., via White Rock, and Oxford to Singerly Station. From White Rock to Oxford, 11 miles, the roadbed of the Peach Bottom R. R. will be used.

Bloomfield Junction.—This company has been chartered in Pennsylvania to build a railway from Bloomfield to a point in Carter township, Perry Co., a distance of 3 miles. W. H. Sponsor, of Pittsburg, Pa., is President.

McKeesport & Versailles Belt Line.—Chartered in Pennsylvania to build a belt railway 5 miles long between McKeesport and Versailles, Pa. W. B. Peters, McKeesport, Pa., is President.

Providence, Ponaganset & Springfield.—It is stated that engineers are at work on this road between Danielsonville and Providence, R. I. The road is projected to run from Providence, R. I., to Springfield, Mass.

Rondout Valley.—A railway company by this name has been chartered in New York.

SOUTHERN.—Existing Roads.

Middle & East Tennessee Central.—J. C. Rodemer, of Gallatin, Tenn., sends us the following:

The grading is nearly completed on the section from Roganna Station to Hartsville, Tenn., a distance of 11½ miles, and tracklaying will begin soon. It is expected to have this section completed by Jan. 1, 1891. The second section from Hartsville to Carthage, Tenn., 18 miles, has been surveyed and will probably be built. The contractors are J. C. Rodemer & Co.

Paducah, Tennessee & Alabama.—A correspondent writes us that tracklaying will reach the Tennessee State line by Sept. 25. The division between the State line and Paris, Tenn., is under contract. This section comprises some very heavy work, and will probably not be completed before March, 1891.

French Broad Valley.—Work has been commenced on the line from Asheville south by W. C. Corpening & Co., who have the contract for 16 miles.

Wilmington, Chadbourn & Conway.—This company will extend its line from Chadbourn, S. C., to saw mills, 10¼ miles. This extension will be laid with steel rails.

Middle Georgia & Atlantic.—Tracklaying is in progress between Machen and Covington, Ga. Work, it is reported, will soon begin on the proposed branch to Social Circle, Ga., 10 miles.

Macon & Dublin.—The grading is nearly completed from Macon to Dublin, 40 miles. A portion of the rails has been received and tracklaying will soon begin.

Charleston, Cincinnati & Chicago.—Tracklaying is being rapidly pushed on the section between Johnson City, Tenn., and Minneapolis, Va. Between Johnson City and the North Carolina State line the road is completed.

Seaboard Air Line.—Tracklaying on the Georgia, Carolina & Northern R. R. from Greenwood, S. C., east has been completed to the Saluala River and work is now in progress on the bridge across that stream.

Empire & Dublin.—The contract will soon be let for completing this road east to Dublin, Ga., 7 miles.

Tavaris & Gulf.—Construction is in progress on an extension of this road from Waite's Junction to Black Lake, a distance of 7½ miles.

Projects and Surveys.

Tallahassee & Northern.—The projectors of this road are endeavoring to secure the money necessary to build the line. It is projected to run from Tallahassee, Fla., to Thomasville, Ga., 40 miles. Geo. W. Saxon, of Tallahassee, is interested.

Cape Fear & Cincinnati.—This company, it is stated, has secured the money necessary to build the road from Southport, N. C., to Charleston, S. C., and will commence work soon. The contract has already been let for the section from Wilmington to Southport. Geo. B. Morton, of Baltimore, Md., is Chief Engineer.

Cincinnati & Atlanta.—Surveys are reported in progress for this road from Athens to Cardiff, Tenn.

Decatur & Greenville Aerial.—This company has been organized to build a railway from Decatur to Greenville, Miss. Joseph Buchanan, Kansas City, Mo., President.

Opelika Terminal.—Chartered to build a railway from Anniston, Ala., to St. Andrews Bay, Fla. John Sibley Marietta, Ga., is interested.

Cumberland, Ft. Payne & Atlantic.—This company has elected Chancellor McSpadden, President, and W. W. Haralson, Secretary. The road is projected to run from Bridgeport, Ala., to Brunswick, Ga.

Midlothen & Tomahawk Church.—Work is reported in progress on a railway from Midlothen to Tomahawk Church, 4 miles.

NORTHWEST.—Existing Roads.

Duluth & Southern.—A contract has been entered into between this company and the St. Louis Land Co. by which the land company takes $100,000 of the stock at par. Work will probably be commenced soon. This is the new name of the Duluth, Red Wing & Southern R. R.

Chicago & Northwestern.—The line from Whitewood to Deadwood, S. Dak., has been completed and opened for traffic. The branch from the main line to Hot Springs, S. Dak., has also been completed.

Burlington & Missouri River.—Good progress is being made on the line to Deadwood, S. Dak. Tracklaying has been completed several miles beyond Bradley's Flat, and the grading has been finished to Custer City. It is expected to have the line completed to Custer City by Oct. 1. Between Custer City and Hill City, the grading is well advanced, with the exception of a few large cuts. Ties and tracklaying material are being delivered along the line and tracklaying will be completed soon.

Projects and Surveys.

Duluth, Pierre & Black Hills.—F. S. D. Broughton, Pierre, S. Dak., Resident Engineer, will soon commence the location of this road from Pierre to Aberdeen.

St. Paul, New Ulm & Southwestern.—According to the prospectus of this road, recently issued, it is projected to run from St. Paul, Minn., to Council Bluffs, Ia., and Omaha, Neb., with a branch from Cherokee, Ia., to Sioux City, Ia. The line has been surveyed from Hopkins to Windom, Minn., 120 miles. It is expected to have the section from Hopkins to New Ulm, Minn., completed by Jan. 1, 1891, and the entire line to Omaha finished by Jan. 1, 1893.

Kewannee, Green Bay & Western.—This line, from Kewannee to Green Bay, Wis., has been surveyed and construction will soon commence.

Nebraska Terminal R. R. & Elevator Co.—A company by this name has been chartered in Nebraska.

SOUTHWEST.—Existing Roads.

Sherman, Denison & Dallas.—A correspondent writes:

This road is projected to run from Sherman to Dallas, Tex., a distance of 80 miles. The work is about medium; maximum grade 65 ft. per mile and maximum curve 4°. The contracts for the first 10 miles of the road have been let, the work to be completed Oct. 1. John P. Hughes, of Ft. Worth, Tex., is the contractor. The officers of the company are: C. H. Osburn, President; R. C. Foster, Vice-President; A. T. Drew, Secretary and Treasurer, and Geo. M. Jarvis, Chief Engineer. The headquarters of the company are at Denison, Tex.

Louisville, New Orleans & Texas.—The Helena incline is now nearly completed and will soon be in operation.

Chicago, St. Paul & Kansas City.—The grading on the Leavenworth & St. Joseph R. R. is rapidly progressing, and track laying is now in progress.

Missouri Pacific.—Surveys are in progress for a line from Carthage, Mo., to Batesville, Ark., a distance of 220 miles. Officials of the company are reported as saying that the line would be built within a year. The extension has been contemplated for some time.

Projects and Surveys.

Ft. Worth & Albuquerque.—Efforts are being made to secure the money necessary to build the first 30 miles of this road.

ROCKY MT. AND PACIFIC.—Existing Roads.

Great Northern.—This company has filed a mortgage for $30,000,000 to the Central Trust Co., of New York, the proceeds to be used in building the western extension from Assinaboine to Puget Sound.

The Seattle & Montana R. R. has awarded the contract for the construction of all the bridges on its line from Seattle to Fairhaven, to the San Francisco Bridge Co. There are four draw spans to be constructed, one at the Skagit, one at the Stillaguamish and two at the Snohomish, and 13 fixed spans of Howe truss. These bridges, according to the contract, must be completed by Jan. 1, 1891. They will cost about $125,000, besides the foundations, and over 2,500,000 ft. of lumber will be used in their construction.

Great Falls & Canada.—This road has now been completed to within 8 miles of the international boundary, about 148 miles, leaving 50 miles more to be built in order to complete the road. Work on the remaining section is light, and it is thought that the entire line will be opened for traffic by Oct. 1.

Rio Grande Southern.—About 40 miles of the grading have been completed from Dallas south, leaving 25 miles more to be finished. Grading is also well advanced on the branch to Telluride. Twelve miles of track have been laid and will be put in operation at once.

Union Pacific.—It is stated that this company will build a branch from its Pioche extension to Iron City, Nev., a distance of 25 miles. The object of the branch is to open up iron mines in the vicinity.

Port Townsend Southern.—The first section of this road from Port Townsend to Crocker's Lake, Wash., has been opened for traffic. From the terminus to Quilcene construction is in progress, and also from Olympia to Union City, Wash. As soon as these two sections are finished a line of steamers will be put in operation between Quilcene and Union City.

Projects and Surveys.

San Jose & Southern.—Organized in California to build a railway from San Francisco Bay along the coast to Los Angeles, Cal., a distance of 400 miles. The officers are: President, J. H. Henry; Secretary, J. R. Patton; Treasurer, B. D. Murphy. Surveys are now in progress.

Eastern Oregon.—Incorporated in Oregon to build a railway from Heppner, Ore., to the coal mines at the head of Butte Creek, a distance of 26 miles, and thence to Sumpter, Ore. Among the incorporators are: W. D. Fletcher, J. H. Roley, T. Rourke and J. R. Dickson.

Coos Bay, Roseburg & Eastern.—A correspondent writes as follows:

This road it projected to run from Marshfield, Ore., via Coquille City, Myrtle Point, and Camas Valley to Roseburg, Ore., a distance of 95 miles. Surveys are now in progress. The route is through a fair agricultural and timber country affording easy grades and curves. The principal business of the road will be in wheat, coal, lumber and general merchandise. R. J. Graham has the contract to build the road, the work to be completed by Dec. 31, 1891. J. R. Sheridan is President, and C. F. Miller is Chief Engineer.

CITY TRANSIT.

Elevated Railways.—***Chicago, Ill.***—The Chicago, Ill., Elevated Railway Construction Co. has been incorporated by M. Lapham, D. W. Sullivan and W. M. Wilson with a capital of $1,000,000 for the purpose of placing the bonds and overseeing the construction of the elevated railway projected by Gen. Torrence.

Dummy Railways.—***Columbus, Ga.***—A line to Girard and Brownville is proposed by a local improvement company.

Albany, Ga.—A line is proposed.

Austin, Tex.—G. W. Breckenridge will, it is said, build a dummy line to the site of the proposed dam in the Colorado River.

Horse Railways.—***Washington, D. C.***—The Anacosta & Potomac River Ry. has been granted permission by Congress to extend its lines on a number of streets.

Cable Railways.—***Oakland, Cal.***—Extensions will be made.

Electric Railways are proposed at Rockville, Md.; Lynchburg, Va.; Radford, Va., address Land & Improvement Co.; at Reidsville, N. C., address J. H. Barnes; between Covington and Porterdale, Ga.; between Americus and Andersonville, Ga.; between New Orleans and Carrollton, La.; between East St. Louis and Madison, Ill. Extensions are proposed at Savannah, Ga.

Lynn, Mass.—The Lynn & Boston R. R. has received permission to operate electric railways over thirteen streets.

Rockland, Mass.—A company has applied for a charter to build an electric line to Hanover, South Weymouth and Abington.

Amsterdam, N. Y.—Work will begin at once on the electric railway, all objections having been removed.

Watertown, N. Y.—An electric railway has been planned, and proposals for its construction are wanted by J. Mullen or S. F. Bagg.

Trenton, N. J.—The Horse Railroad Co. contemplates adopting electricity on all parts of its system.

Altoona, Pa.—The City Passenger Ry. has voted to increase its capital stock from $103,000 to $180,000, for the purpose of operating the line by electricity.

Pittsburg, Pa.—The Suburban Rapid Transit Co. has applied for permission to extend its lines on several streets.

Sharpsburg, Pa.—The Citizens' Electric Ry. will extend its lines about 1¼ miles, it is reported.

Knoxville, Pa.—The Pittsburg & Birmingham Traction Co. will extend its lines to Knoxville & Beltzhoover, a distance of 6 miles.

Richmond, Va.—The North Side Land Co. will build a line of some length on both sides of the James River.

Atlanta, Ga.—The Atlanta, West End & McPherson Barracks R. R. will build 4¼ miles of line.

Macon, Ga.—The Home Electric R. R. will lay 3 or 4 miles of track to a point in Houston Co.

Knoxville, Tenn.—H. G. Bishop is surveying a route to Fountain Head, a distance of 6 miles.

Knoxville, Tenn.—The Chilhowee Street Ry. has been incorporated with J. W. S. Frierson as president, and H. S. Mabry as secretary.

Dubuque, Ia.—The storage battery system is to be tried here as well as in Ottumwa, Keokuk, Des Moines and other cities of Iowa.

Waco, Tex.—The Citizens Ry. will operate its lines by electricity.

Seattle, Wash.—The Rainier Avenue Electric Railway Co. has been incorporated with a capitalization of $250,000 to build a 7-mile line to Lake Washington.

New Companies.—Onondaga Lake Ry., Syracuse, N. Y.; capital stock, $250,000; will build a 7-mile line.—Williams Valley Electric R. R., Lykens, Pa.; capital stock, $125,000; incorporators, A. F. Engelbert, H. G. Williams, J. I. Delaney and others.—Columbia Central R. R., Washington, D. C.; capital, $300,000; incorporators, J. P. Poe, T. M. Lanahan, F. Brown and others.—Alexandria & Fairfax Passenger Ry., Alexandria, Va.; President, I. Eichberg; Secretary, M. B. Harlon.—Sumter, S. C., City Ry. & Freight Co.; capital stock, $10,000.—Sioux City & Sergeant Bluffs Transit Co., Sioux City, Ia.; capital stock, $100,000; incorporators, J. P. Blood, A. Crossan, J. D. Ford and others.—River-side Street Ry., Fort Worth, Tex.; capital stock, $200,000; incorporators, F. E. Chase, E. W. Taylor, W. Bering and others.

HIGHWAYS.

New Jersey.—The residents in Somerset Co., will apply to the next Legislature for the right to appoint a road commission, composed of one member from each township, who shall serve without pay, and and have power to appoint a supervising engineer at a fair salary.

Arizona.—A wagon road over the mountains between Castle Creek and Minneha Flat, will be built at an estimated expense of $100,000 by Phœnix parties.

BRIDGES, TUNNELS AND CANALS.

Bridges—***Antrim, N. H.***—A bridge will be built over the Contoocook River to connect Antrim and West Deering, N. H.

Pittsburg, Pa.—It is probable that the bridge over Sixth street will be built after the design submitted by Gustave Lindenthal. The new bridge is to have three spans, each to be 350 ft. long. There will be two piers, and the bridge will be the same height as the present structure, so that there will be no change in the Federal street grade. At each end of the new bridge is to be a tower 80 ft. in height. The bridge is to contain four tracks, the center tracks for cars and the outside tracks for vehicle traffic. There will be two 12-ft. sidewalks paved with asphalt. The width of the new bridge will be 65 ft., which is 15 ft. narrower than Federal street.

Charleston, W. Va.—A bridge will probably be built over the Little Kanawha River at George street.

Dublin, Ga.—Bids will be received until October 20 for building an iron bridge across the Oconee River. The bridge is to be 320 ft. long and 18 ft. wide, with a draw of 80 ft. clear space on each side of the turn-table or center of the draw, over the channel.

Also, at the same time, sealed bids will be received for the building of the wooden trestle or approaches to the bridge, about 700 or 800 ft. long and 18 ft. wide, and to be constructed upon piling and above extreme high-water.

Atchison Co., Kan.—Proposals will be received by the County Commissioners for constructing a 75-ft. iron span bridge across Independence Creek, estimated cost, $1,515; a 72-ft. iron span bridge, and raising and repairing stone abutments, across Independence Creek, estimated cost, $1,198.

St. Charles, Mo.—The Senate has passed the House bill for the erection of a pontoon bridge across the Missouri River between St. Charles City and St. Louis Co., Mo.

Marble Falls, Tex.—A stock company has been organized to construct a bridge across the Colorado River. S. E. Holland, President; A. Struve, Vice-President, and Wade Border, Secretary.

Napa, Cal.—The citizens of Napa, Cal., are considering a proposition to bond the city for $20,000 to build a bridge.

WATER-WORKS.

NEW ENGLAND.

Conway, N. H.—We have received the following information from John C. L. Wood, Secretary:

Work was commenced on Sept. 1, and is to be completed about Nov. 1. There will be 3¼ miles of cast-iron coated pipe, and 21 hydrants. Mathew's hydrants and Eddy valves will be used. The pipe will be furnished by R. D. Wood & Co., Philadelphia, Pa. F. A. Snow, Providence, R. I., is the contractor for the Conway Aqueduct Co. President, W. S. Abbott; Secretary and Treasurer, John C. L. Wood; Superintendent, B. F. Clark. Designing Engineer, J. A. Farrington. Constructing Engineer, H. S. Ferguson. The supply will be furnished by gravity from Cold Brook. A reservoir will be constructed. Cost, $15,000. The consumers will pay $6.0 per year, and the town will pay an annual rental of $20 per hydrant.

East Providence, R. I.—Extensions are projected.

Portsmouth, N. H.—The Portsmouth Aqueduct Co. has sold its plant and franchise to the city. The selling price was $150,000. The city pays $15,000 in cash, and is to pay the remainder of the purchase money by Jan. 1, 1891. M. Goodrich, City Clerk, has sent us the following:

The plant does not come into the city's possession until Jan. 1, 1891. Nothing in the way of improvements, etc., will be done previous to that date, except to arrange for the development of the plant. It is now a question how far the city can act without consent of the Legislature which convenes in January.

MIDDLE.

Hoosick Falls, N. Y.—Engineer E. D. Smalley, Canastota, has sent the following:

Works to be owned by the village will probably be started this year and finished next. Cast iron pipe will convey water by gravity from White Creek, 7 miles distant, to a 1,500,000-gall. distributing reservoir on an elevation of 200 ft. There will be about 75 hydrants. Plans and specifications are nearly completed. [The Hoosick Falls Water Supply Co. built works here in '86-7. Ed.]

Tarrytown, N. Y.—J. A. Lockwood has been awarded a contract for sinking two wells for increasing the water supply at $11,000.

Watkins, N. Y.—E. D. Smalley, Engineer, has sent the following:

Pipe-laying is being rapidly done, and work on the lower reservoir has been commenced. Most of the supply will be from springs about 400 ft. above the village. The overflow from the upper reservoir will pass to the lower, and any deficiency in the supply will be met by pumping from Seneca Lake.

Freehold, N. J.—The Eddy Valve Co., of Waterford, N. Y., has been awarded the contract for furnishing the hydrants and valves for the new works. About 50 double nozzle, 4½-in. connection hydrants will be set at once, and about 80 10 to 4-in. valves will be required. The pipe will be furnished by the Union Hydraulic Works, of Philadelphia, Pa. H. B. Pitcher, of Long Branch, N. J., has the contract for pipe-laying, setting hydrants, etc.

Rutherford, N. J.—The question of establishing a system of water supply is being discussed. Wolcott C. Foster, of New York, has offered to submit a proposition to the town if the council will grant a franchise. The proposed source of supply is a branch of the Passaic River, and the present plan is to secure sufficient water to supply this and adjacent towns. The Hackensack Water Co., of Hoboken, will submit a proposition to the town.

South Orange, N. J.—Water bonds for $20,000, bearing 4% interest, and running 20 years, are to be issued at par. Attention is called to an advertisement in another column for pipe-laying, etc.

Summit, N. J.—A deed of sale of the plant of the Commonwealth Water Co. to the Mountain Water Co. has been filed. The purchase includes land and the right of way through the streets of Summit and other privileges conferred by the township authorities on the Commonwealth Company. The price paid was $120,000.

Bridgeton, Pa.—The East Lake Woolen Mfg. Co. has demanded payment for the water supply, which is the waste water from East Lake, and it is probable that a new source of supply will be investigated and adopted.

Brushton, Pa.—A sub-committee has been appointed by the City Council to investigate the question of a system of water supply and report results at the next regular meeting.

Westfield, Pa.—The Westfield Water Co. has been chartered. Capital, $25,000.

SOUTHERN.

Basic City, Va.—It is reported that the contract for constructing works has been awarded to Holtzclaw Bros., Washington, D. C.

Wheeling, W. Va.—A plan is proposed for increasing the water supply, providing for the construction of a new pumping station two or three miles above the city. Dr. George Baird is chairman of the committee which has the matter in charge. The Water Board has been directed to employ an engineer to ascertain the cost of erecting a suitable power house, and also to have an analysis of the river water made from samples taken at different points to decide upon the proper point to locate the station in order to obtain a pure supply. Two pumps, of 16,000,000 galls. daily capacity, respectively, will be purchased if the proposed plan is prosecuted.

Darlington, S. C.—The Darlington Water-Works Co. has been chartered, with a capital stock of $4,000. The company proposes to supply water to the town for all purposes.

Gaffney City, S. C.—F. G. Stacy has sent us the following information:

Contracts will be let as soon as the city can obtain legal authority to issue bonds. It is now proposed to issue town bonds for $20,000 to $25,000. The city proposes to build and own the works. The supply will be taken from limestone springs, one mile distant. A board of appraisers has been appointed by the Town Council to ascertain the amount of taxable property within the town limits. When this is completed, a tax is to be levied sufficient to pay for the works. Population, 2,000.

Laurens, S. C.—It is reported that the New York Construction Co. has been awarded the contract for constructing a system of works.

Atlanta, Ga.—Another election has been called for Oct. 14, to vote on the question of issuing the 4% bonds for establishing the water supply system.—Attention is called to the improvements contemplated as set forth in our "Proposals Open" column.

Columbus, Ga.—Bids are wanted for sinking an artesian well by D. P. Dozier, Mayor.

Gainesville, Ga.—It has been recommended by the Water Commissioners that the city build its own works, instead of awarding contracts.

Macon, Ga.—Engineer J. H. Powers has about completed surveys for the canal to be constructed for conveying an additional water supply to the city. It will be about ten miles long.

Savannah, Ga.—Superintendent James Manning is reported as stating that as soon as the two wells now being put down are completed work in putting down five wells on the Springfield plantation will be commenced. Also that "the present works needs a high duty engine, as the low-duty engine now in use does not furnish great enough pressure to carry the water to the height desired."

Gainesville, Fla.—The City Council has taken steps to have an artesian well bored.

Ocala, Fla.—The proposed election to vote on the question of issuing bonds has been abandoned.

Fulton, Ky.—Sealed proposals for works will be received by the Mayor and Common Council until Oct. 1. Geo. Cadogan Morgan, 15 Major Block, Chicago, is the Engineer. See Proposals columns for further information.

Knoxville, Tenn.—The ordinance introduced by R. N. Hood, President of the water company, authorizing the company to bond its works for $500,000 for improvements, has been passed by the City Council. Engineer Loring, of Boston, Mass., is reported by the *Journal* as stating:

That the pumping station should have two pumps, each of 5,000,000 galls. daily capacity; that a reservoir should be built with a capacity of 20,000,000 galls.; also that either large settling basins or a thorough system of filtration should be put in, and he was inclined to think the latter plan the best.

A general investigation of the plant is to be made, as well as surveys to decide whether the pumping station should be moved or not, by the city engineer, the water company's engineer and an engineer to be sent from Boston by Mr. Loring.

Nashville, Tenn.—The city expects to have the new Worthington pumps in operation by Nov. 15, which will increase the total daily pumping capacity to about 30,000,000 galls. The Board of Public Works has an option on another 10,000,000 gall. Worthington pump for the new station, and according to the *American* it is quite likely that this pump will be purchased. This will give the new station a pumping power of 30,000,000 galls. daily independent of the old station.

NORTH CENTRAL.

East Liverpool, O.—Work is soon to be commenced on the new high service reservo ir to be located on Houston Hill.

Goshen, Ind.—Artesian wells as a source of supply have proven insufficient, and there is a scheme on foot to pipe water from Wolf Lake. Estimated cost, $20,000.

New Albany, Ind—The water company has purchased 8 acres of land adjacent to its reservoirs, and will commence as soon as practicable the construction of an additional reservoir. The company now has in use 3 large reservoirs, and the fourth is to be used as a settling basin.

Muskegon, Mich.—Wm. Dixon, Superintendent, informs us that all the contracts have been let for the new supply from Lake Michigan. Chester B. Davis, Chicago, is the Engineer.

Canton, Ill.—Extensions are to be made.

Centralia, Ill.—Several systems of water supply are to be examined by members of the City Council and others, to decide upon a plan for constructing the new works. They will probably be built and operated by a local company.

Madison, Ill. (P. O. probably at Long Lake).—A report from Venice, Ill., states that plans are being prepared for a system of water supply to be established by the improvement company.

Monticello, Ill.—The City Council has voted to establish an artesian well system of water supply.

NORTHWESTERN.

Algona, Ia.—City Clerk W. B. Quartor has sent us the following information:

Harrison & Hawley, of St. Paul, Minn., have been awarded the contract for building the new works.

Correctionville, Ia.—The city has voted in favor of constructing works.

Iowa Falls, Ia.—We have received the following from Charles Elliott, Editor of the daily *Sentinel:*

The town voted on Sept. 1 authorizing the council to establish a system of works, but defeated the proposition to issue bonds to pay for same. The council may make arrangements with some private corporation to put in a system.

Another report states that it is probable that a home company will be organized, or that outside parties will be permitted to build and operate a system.

Wilton, Ia.—The following is from J. E. Park, Recorder:

Contracts will be let as soon as specifications are completed. Water will be pumped from an artesian well to a tank. Probable cost, $10,000. The town has voted to issue $14,000 of bonds. Population, 1,200.

Estherville, Ia.—The City Council has decided to submit to a vote the question of levying a tax to build works.

Abilene, Kan.—The Penn Mutual Insurance Co., the present controller of the existing works, will probably expend $50,000 in improving the works and securing a pure water supply.

Ellsworth, Kan.—Sealed proposals will be received at G. A. R. headquarters, Sabetha, Kan., until Oct. 10, for furnishing all the material and constructing a system of water-works on the reunion grounds, Ellsworth, Kan. Address Ira F. Collins., Chairman Board of Trustees. G. A. R., or A. R. Greene, Secretary.

Leavenworth, Kan., and Caldwell, Idaho.—The Montgomery Co. (Kan.) and Caldwell Real Estate & Water Co. has been incorporated to carry on business in these places.

Topeka, Kan.—The following is from the daily *Capital:*

The new Water Supply Co., has made a proposition to move its works up the river west of the asylum and to give the city clean, pure water. The present system of supplying the city is not adequate to our increased growth and the quality of the water is far from being as good as it should be. Every aid that the city council can give the new company in perfecting its plans will be heartily endorsed by the citizens. We need plenty of clear pure water and we need it very much.

Crawford, Neb.—Bids for constructing works will be opened on Sept. 20, by A. A. Richardson, Engineer, of Lincoln, Neb. About 8,000 ft. of 8 and 6,000 of 6-in. pipe will be needed. The pressure on the 8-in. pipe will be 120, and on the 6 in. 30 lbs. Bids may be for cast or Kalamein iron, spiral steel or wood pipe.

Greeley Center, Neb.—The town wishes to have a system of works established.

Hebron, Neb.—A vote is to be taken on Sept. 15 on the question of issuing $25,000 of bonds for building works.

Omaha, Neb.—The City Council has refused to admit the Economical Water-Works Co.

Chamberlain, S. Dak.—C. C. Morrow informs us that the city wishes to sell its works. J. D. Farrell is now Superintendent.

Fargo, N. Dak.—W. F. Ball, Mayor, informs us that the Fargo Water & Steam Co.'s works will be bought by the city at a price to be fixed by arbitration. No extensions will be made before next year.

New Castle, S. Dak.—The new works have been completed. Water is brought from springs. There are 14 miles of pipe.

Laramie, Wyo.—The question of a more adequate supply of pure water is being considered. The present supply is said to be unfit for use.

Dillon, Mont.—Regarding the projected works, Phil. Stelzer, City Clerk, sends us the following:

The town is now waiting to learn whether the parties to whom the franchise has been granted will carry out their agreement or not.

Moose Jaw, N. W. Ter.—The by-law to raise $10,000 for constructing water-works bas been defeated.

SOUTHWESTERN.

Hannibal, Mo.—C. J. Lewis, Superintendent, has sent the following:

The construction of the proposed new 25,000,000-gall., reservoir will not be started before next spring. The site has been purchased, but the plans and specifications are not yet out.

Hebron, Neb.—A vote will be taken on Sept. 15 on the question of establishing a water supply.

Independence, Mo.—The following is from R. D. Wirt, Superintendent:

The stockholders of the independence Water Co. voted Sept 4 to increase their bonded debt from $60,000 to $100,000. As soon as the bonds are sold improvements will be commenced. No contracts have been let. There will be two new 750,000-gal. duplex steam pumps, a 15 × 125-ft. stand pipe, and perhaps two mile of 14 and several miles of 4-in. mains.

St. Louis, Mo.—Bids for furnishing the pumping engines for the new low-service station at the Chain of Rocks have been received from Henry R. Worthington, New York; Builders' Iron Foundry, Providence, R. I.; Holly Mfg. Co., Lockport, N. Y. The prices range from $300,000 to $340,000.

Sunset, Mo.—The Sunset Hill Electric Light, Water and Power Co. has been incorporated at St. Louis. Capital, $100,000. The incorporators are: Marcus Bernheimer, Herman Tuholske, Ganil M. Lederer.

Comanche, Tex.—The following is from J. F. McCarty:

No date for letting contracts has been decided upon, but it is probable that the works will not be built until 1891. Experiments are to be made with artesian wells as the source of supply. Population, 2,000.

Galveston, Tex.—Sealed proposals will be received until Sept. 25 for boring an Artesian well to a depth of 3,000 ft., unless satisfactory water is procured at a lesser depth. Bidders to give price per ft. for finishing with 6, 8, 10 and 12-in. pipes respectively. Address Thos. W. Jackson, Chairman of Special Committee.

Georgetown, Col.—Alderman Foster has introduced a resolution providing for an election to vote upon the question of issuing $50,000 of improvement bonds, the larger portion of which would be used in purchasing the existing plant from the water company, if it can be secured at a reasonable price, or in constructing an entirely new and improved system of works.

Hallettsville, Tex.—Plans and specifications for a system of works have been completed. The estimated cost is $16,000. Water will be taken from the Lavaca River. Bids will soon be wanted.

PACIFIC.

Centralia, Wash.—The following is from the Portland *Oregonian:*

J. A. Miller, who is interested in the water-works franchise, reports that the engineers have almost completed surveys and that work will be begun at an early day. The water will be brought from the Newaukum River and stored on Seminary Hill in a 5,000,000-gall. reservoir 230 ft. above the level of the Northern Pacific R. R.

Tacoma, Wash.—The following is from Chas. B. Hurley, General Superintendent:

The preliminary surveys for the new gravity supply from the Green River are nearly completed. The intention is to take water from the river at a point about 32 miles from the city, starting with an elevation sufficient to carry the water 500 ft. above the tide in Tacoma. A new 25,000,000-gall. reservoir has been proposed for the middle service, and a 0 × 125-ft. iron stand-pipe now under construction will supply the high service. The old reservoir will supply the low service. The estimated cost of the various improvements is $1,400,000. Chas. P. Darrach, of Philadelphia, is engineer for the new works.

Tacoma, Wash.—The Northern Pacific, Yakima and Kittitas Irrigation Co. has been incorporated at Olympia. The incorporators are: William Kerr, Paul Schulze, Walter Grainer and Walter Oakes. The objects for which the corporation is formed are: To appropriate, collect and use the waters in the lakes, natural water courses and rivers in Yakima and Kittitas counties for the purpose of irrigation. To use or sell the same for manufacturing, the supplying of cities and towns with fresh water for domestic and other uses, and for agricultural purposes; for such objects to erect, own and operate dams, reservoirs, canals, ditches, pipe lines, acqueducts, etc. The amount of the capital stock is $500,000.

Waitsburg, Wash.—The town is to be supplied with water from artesian wells.

Portland, Ore.—The following is taken from a recent report submitted by Isaac W. Smith:

A 2,000,000-gall. pump, to be followed by a meter system, would, I think, be sufficient for several years to come. The cost of the pump, boilers, buildings, etc., would be from $25,000 to $35,000, according to the location.

The pump now in operation will be sufficient until next summer; but if a new pump is to be erected at that time it will be necessary to order it at least six months in advance.

Investigations are also being made of the cost of supplying Portland Heights with water. If the plan is carried out, a considerable amount of pipe, supplies, etc., will be required in addition to the materials required in connection with the above.

Llano, Cal.—Sealed proposals will be received at the office of the Board of Directors of Big Rock Creek Irrigation District until Sept. 24 for the purchase of $50,000 of bonds. Address Ira Carter, Secretary, for information.

San Jose, Cal.—The incorporators of the Glen Weber Water Co. are: J. W. Combs, C. M. Weber, H. A. Brainerd, T. B. Kell, G. Brown, B. L. Ryder and J. A. Combs, all of San Jose.

CANADA.

Lachute, P. Q.—The Montreal *Gazette* states:

Three water-works petitions are now in circulation in Lachute: One in favor of giving privileges to the old company, one in favor of the town owning the works, and a third in favor of abandoning the whole thing.

Montreal, P. Q.—The following bids have been received:

Furnishing 75 double nozzle hydrants: Miller Bros. & Mitchell, $72.50; E. Chanteloup, $78; Garth & Co., $67.50; J. McDougall, $70; W. E. Gower, $69.25 The tender of Messrs. Garth & Co. at $67.50 each was accepted. Special castings: E. Chanteloup, $48; Amesse, $45; J. McDougall, $45; Thos. Scanlan, $44.75; H. R. Ives & Co., $43.80. H. R. Ives & Co.'s tender was accepted.

ARTESIAN WELLS.

Paris, Tex.—Bids are wanted for sinking a well, by the Secretary of the Board of Trade.

Armour, S. Dak.—Bids will be received until Sept. 25 for $4,500 of 10 year 7 % bonds, by C. W. Trent, Clerk.

Aylmer, Ont.—The following is from Alex. Milne Town Engineer:

The following wells from which the new supply is to be obtained will be further developed. On Jan. 5, next, the people will vote on the question of increasing the pumping plant, constructing a reservoir and laying two miles of new mains. [The system was built in 1884 for fire protection and lawn sprinkling.—ED.]

IRRIGATION.

Randall Co., Tex.—The incorporators of the Hoffman Irrigation Co. are: T. Hoffman, M. Schwartz and John Singer.

Santa Fé, N. M.—The Irrigation and Hydraulic Mining Co., a New York corporation which has been at work on the San Pedro placer mines in Santa Fé Co., has filed a trust deed to the Farmers' Loan and Trust Co., of New York, to secure the payment of $2,000,000 6% bonds to run 10 years.

The securities have been placed in London and the proceeds are to be used in piping the waters of the Pecos River 45 miles across the southern part of this county to San Pedro, where the company owns about 6,000 acres of placer ground. The company is operating under the special charter granted years ago by the New Mexico Legislature to S. B. Elkins and others.

San Francisco, Cal.—The Kern County Canal and Water Co. has been incorporated. The directors are; Henry Wadsworth, of Alameda Co., and Lloyd Tevis, James B. Haggin, Irwin C. Stump, Will S. Tevis, of San Francisco. Capital stock, $5,000,000.

Boise City, Idaho.—The Boise Land and Irrigation Co. has been incorporated. The capital is $50,000. The object is general dealing in water for irrigation and other purposes.

Palmdale, Cal.—The taxpayers of Palmdale Irrigation District (40,000 acres) voted on Sept. 10 on the question of building a bed-rock dam in Little Rock Creek and to increase the time of flow so as to save the storage reservoir until late in the year. A thorough system of irrigation ditches, to wholly utilize the winter supply, is to be constructed.

SEWERAGE AND MUNICIPAL.

Sewers are ordered at Buffalo, N. Y., 20, 18, 15 and 12-in. pipe; Troy, N. Y., 27 × 40-in. brick; Winston, N. C.; Jacksonville, Ill.

Lynn, Mass.—The Board of Aldermen has authorized the finance committee to borrow $35,000 for sewerage purposes.

Chelsea, Mass.—The sewerage committee has recommended the construction of sewers costing $14,150.

Boston, Mass.—The construction of a number of sewers at an estimated total cost of $448,300 has been recommended by the superintendent of sewers.

Waukegan, Ill.—A sewerage system for the central portion of the city is under discussion.

Vicksburg, Miss.—Engineer Honey has submitted plans for a sewerage system costing approximately $192,000.

Duluth, Minn.—Assessments of $48,000 for building sewers have been made.

Paving has been ordered at Providence, R. I., macadamizing; Brooklyn, N. Y.; New York City; East Orange, N. J., macadamizing; Washington, D. C., asphalt; Cincinnati, O., macadamizing; Columbus, O.; St. Louis, Mo., cedar block; Los Angeles, Cal., granite block, also some gravel roads; Portland, Ore.

Buffalo, N. Y.—Asphalt paving costing $113,412, German rock asphalt paving costing $43,000, and extensions costing $18,000 have been ordered.

Long Island City, N. Y.—The Queens County Supervisors have adopted a resolution in favor of bonding the city for $70,000, to be used in highway improvements.

Newark, N. J.—The City Surveyor has recommended that 26.57 miles of streets be improved at an estimated expense of $1,015,000. The amount of pavement at present in Newark is: granite block, 8.75 miles; trap rock, 3.06 miles; Telford, 10.86 miles; sheet asphalt, 0.56 miles; block asphalt, 0.28 miles; coal tar, 0.11 miles; cobblestone, 25.31 miles; total, 48.93 miles. The improvements contemplated involve 1.53 miles of granite block pavement, at $2.75 per sq. yd.; 3.11 miles of oblong and square trap block at $2.45 and $1.75 per sq. yd. respectively; 1.10 miles of sheet asphalt, at $2.80 per sq. yd.; and 2.09 miles of Telford at $1.10 per sq. yd.

Philadelphia, Pa.—The Department of Public Works is so short of money that it will be unable to carry out its plans unless another appropriation is made. Much of the asphalt paving is in very bad condition and at least $11,000 is wanted to repair it. Director Wagner recently asked for $51,165 for street improvements.

New Streets will be opened in Montreal, P. Q., and St. Paul, Minn.

ELECTRICAL.

Electric Light plants are proposed at Butler, Pa.; Florence, S. C.; Chattanooga, Tenn., address J. A. Hart; Princeton, Ind.; Venice, Ill.; Rockport, Tex., addres, Barlow & McCoy.

Hull, Mass.—The Nantasket Electric Light & Power Co. has been incorporated by E. Thayer, C. T. Harrington, A. W. Hastings and others.

New York City.—The Edison Electric Illuminating Co has given notice that their prices will be reduced to 1 cent per hour for each 16 c. p. lamp or proportionate charge for lamps of greater power or for motor service.

Eastport, Md.—The village has contracted with the Annapolis Electric Light Co. for five 2,000 c. p. arc lights at $120 each per year.

Glasgow, Va.—The Rockbridge Co. will build an electric light and power plant.

Montgomery, Ala.—The Ball Electric Light & Power Co. has applied for incorporation.

Joliet, Ill.—The Joliet Electric Light Co. and the Thomson-Houston Co. have sold out to a new syndicate, the Economy Light & Power Co., having $400,000 capital. The new company will utilize the great water power near the town to furnish electric light and power at a reduced rate.

Santa Fe, N. M.—The Santa Fe Electric Co. has been incorporated with $25,000 capital by E. T. Webber, T. B Catron, J. G. Shumann and others.

CONTRACTING.

Sewers.—*Troy, N. Y.*—Bids recently received for constructing a 30×45-in. brick sewer ranged from $3.87 to $5.62 per lin. ft. Bids for a 27×40-in. ranged from $4.19 to $4.94 per lin. ft.

Evanston, Ill.—The contract for laying the sewerage system has been given to E. B. Hammond at $40,700.

St. Louis.—The following bids for a large sewerage contract were recently opened: Fruin-Bambrick Construction Co., $262,250; A. Heman, $241,255. The award has not yet been made.

Kansas City, Mo.—Bids for building the sewers in district 130 ranged from $55,432 to $48,207, the latter being that of P. MacDonald, who has been awarded the contract.

Street Lighting.—*Halfax, N. S.*—The bids recently received for street lighting were as follows: Halifax Illuminating Co., 1,200 c. p., $72 per lamp; 2,000 c. p., $79 per lamp; Thomson-Houson Co., $70-$76; Yarmouth Mercantile and Manufacturing Co., $68-$73; St. John Eastern Electric Co., $62-$69.

London, Ont.—The following bids were recently opened for supply and electric light plants:

	240 lights, 2,000 c. p.	300 lights, 1,000 c. p.	280 lights, both 1,000 and 2,000 c. p.
Royal	$44,525	$44,750	$46,495
Edison	47,350	45,051	52,430
Ball	40,875	41,500	41,675

Toronto, Ont.—The following bids were recently received for lighting the streets: The Toronto Electric Light Co. offered to supply 800 arc lights for 2 years at 38 cts. per night, for 3 years at 33½ cts., and for 5 years at 29½ cts.; the Consumers Gas Co. tendered for the exclusive lighting of the streets, offering a 13¼ c. p. lamp a $19.50 and a 17 c. p. lamp at $22 per year. For a 3-year contract the prices were $19 and $21.50; on a 5-year contract $18 and $20.50. For 150 c. p. Lambeth lamps the figures were $77.50, $75.75 and $72.50.

Levee Work.—*Louisiana.*—Recent bids for levee construction were: Coulon levee, Andrews & Ogden, 18.97 cts. per cu. yd.; Ducherry levee, T. J. Coffman, 19¼ cts. per cu. yd.

Repaving.—*Brooklyn, N. Y.*—Recent bids were as follows: Repaving with granite blocks, $2.22 to $2.36 per sq. yd.; new curb, 20 to 55 cts. per lin. ft.; new bridge, bluestone, 10 to 50 cts. per sq. ft.; new bridge, granite, 60 to 75 cts. per sq. ft.

Garbage Cremation.—*St. Louis, Mo.*—The contract for burning the city garbage has been awarded to the St. Louis Reduction Co. at 9 cts. per 100 lbs. The company will use the Mertz process.

PROPOSALS OPEN.

Sewers.—*Troy, N. Y.*—E. O. Ross. Sept. 16.

St. Paul, Minn.—R. L. Gorman. Sept. 15.

Buffalo, N. Y.—A number of 18, 15, 12 and 10-in. tile sewers. G. E. Mann. Sept. 15.

Grading.—*Pittsburg, Pa.*—Grading, paving and curbing. E. M. Bigelow. Sept. 16.

New York City.—Grading on several streets. T. F. Gilroy. Sept. 18.

St. Paul, Minn.—Grading and sewering. R. L. Gorman. Sept. 15.

Paving.—*Troy, N. Y.*—Granite block. E. O. Ross. Sept. 19.

New York City.—Asphalt. T. F. Gilroy. Sept. 12.

Buffalo, N. Y.—G. E. Mann. Sept. 15.

Cleveland, O.—Grading and paving with fire brick. C. G. Force. Sept. 18.

St. Louis, Mo.—A number of large contracts will be let on Sept. 23. G. Burnet.

St. Paul, Minn.—Cedar block. R. L. Gorman. Sept. 15.

Bridge.—*Cincinnati, O.*—Plate girder highway bridge. F. Raine. Sept. 27.

Lock Construction.—*Cumberland River.*—Lieut Col. J. W. Barlow. Nashville, Tenn. Sept. 23.

Artesian Wells.—*Paris, Tex.*—Address Board of Trade.

Galveston, Tex.—T. W. Jackson. Sept. 25.

Yoakum, Tex.—M. G Ranney. Sept. 20.

Levee Work.—*Tallulah, La.*—Construction of 6 levees; approximate contents, 580,000 cu. yds. Levee Board. Sept. 29.

Furnishing and Laying Water Pipe.—*St. Louis, Mo.*—About 3,100 ft. 4-in. pipe with 1 ton special castings, 4 White's patent hydrants and 3 stop valves. G. Burnet. Sept. 16.

Water-Works.—*Sabetha, Kan.*—Complete water-works plant. I. F. Collins. Oct. 10.

Breakwater.—*Walton, N. S.*—A. Gobiel, Ottawa Sept. 19.

Wharves.—*Bridgetown, N. S.*—A. Gobiel, Ottawa. Sept. 19.

New York City.—Estimated quantities; 518 M. ft. pine, spruce and oak timber, 709 pine and 14 oak piles, 48 tons spikes, bolts, straps, etc. Dock Dept. Sept. 10.

MANUFACTURING AND TECHNICAL.

Cars.—The Columbus, Hocking Valley & Toledo Ry. has recently added 1,500 coal and 500 box cars to its rolling stock. The company's shops have turned out 50 flat and 50 gondola cars, while 75 coal cars have been purchased from the Lafayette Car Works. The Pullman Co. is working on a 40-car order from the Illinois Central R. R. The same company is building a cathedral car for the Right Rev. William D. Walker, of North Dakota. The Bishop will travel in it through sparsely settled portions of the State, holding services in the car, which will be 60 ft. long.

The Lake Shore & Michigan Southern Ry. has ordered about 1,200 cars for next summer's delivery. From 600 to 1,000 wear out annually on this line. The East Tennessee, Virginia & Georgia R. R. has received six 60,000-ton cars from the U. S. Rolling Stock Co.

Locomotives.—The Illinois Central R. R. recently placed an order for 25 locomotives with the Brooks Locomotive Works, Dunkirk, N. Y. The engines will be of the American type, with cylinders 18 × 24 ins., driving wheels 62 ins. in diameter, and will weigh in working order about 104,000 lbs. This road has been purchasing a large number of engines recently, all of which are large ones for their respective types. The previous orders have been mostly for moguls and 10-wheeled engines. The Pittsburg Locomotive Works have received an order from the Louisville, St. Louis & Texas R. R. for 6 freight engines. It is reported that the Canadian Pacific has placed an order for 30 new locomotives, most of them to be used on the Western lines.

The first American locomotives, two in number, which were ever set up in Japan were tested on the Railway of Japan July 22, between the capital and Shinagawa, a suburban station. They were sent out from the Baldwin Locomotive Works, and it is reported that they were so superior to the English engines hitherto in use that the authorities will put the American locomotive into use on the line.

The Minnesota Iron Car Co. is making arrrangements to manufacture the Arnold refrigerator car. The patentee of this car is W. J. Arnold, of the Armour Packing Co. and a company with a capital of $10,000,000 has been formed to handle it.

The Basic City (Va.) Car Works Co. is erecting machine shops and foundry 60x100 ft., planing, tongue, and grooving mills 60x100 ft. each, erecting shops 60x143 ft., and paint shop 17x143 ft.

The Dunham Mfg. Co. has removed its business offices at Chicago to 703-7 Phenix Building, where all correspondence is received. The New York office is at 130 Broadway.

William Sellers & Co., of Philadelphia, are building for the Baldwin Locomotive Works' new shops two 100-ton high speed traveling cranes, each with two 50-ton trolleys for a span of about 75 ft. and for a shop about 340 ft. long. Each crane is to be driven by electric motors on a hanging platform.

The Phœnix Iron Co., of Phœnixville, Pa., has been awarded the contract for the iron and steel work of the Crocker building, at San Francisco, which will cost about $1,250,000. The Phœnix Iron Co. has also the contract for all the iron and steel for the Washington Loan and Trust Co. building, at Washington, D. C.

An iron and steel lighthouse is to be built at Sea Girt, N. J.

The Abendroth & Root Mfg. Co. recently shipped 12 miles of 12 to 20-in. water type for the Nicaragua Canal. It is of the spiral riveted pipe, made of riveted sheet iron and cemented with asphalt.

The Shackleton Car Heating & Ventilating Co. has sold its plant at Bound Brook, N. J., under a forced sale, to C. C. Jordan, Pres't. of the New York Iron Car Co.

The Wilson & Baillie Mfg. Co., 85 Ninth St., Brooklyn, has recently patented a sewer-pipe machine, by means of which as much cement pipe can be turned out per day as 100 men can make by hand. The product is also said to be superior to the hand-made pipe. The company is also engaged in handling the granite for the Memorial Arch at Prospect Park, its unusually heavy cranes and dock machinery allowing a rapid discharge of the stone barges.

The Otto Gas Engine Co., Philadelphia, recently made what is claimed to be the largest gas engine ever constructed in this country. It is of 100 HP. and weighs 30,000 lbs.

The Sterling Emery Wheel Co. will remove its works from Sterling, Mass., to Tiffin, O., where a 200 × 60 ft. shop has been bought. The New York office will remain at 174 Fulton St.

The Buffalo Steam Pump Co. has furnished over 30 water-works plants with pumping machinery during the past 2 years. The factories are now running 15 hours a day.

New Companies.—Georgia Rolling Stock Co., Macon, Ga.; capital stock, $250,000; incorporators: H. J. Lamar, J. S. Schofield, J. S. Baxter and others. Gillette Electric Gate Co., Chicago, Ill.; capital stock, $1,000,000; incorporators: H. Gillette, E. L. Prussing, B. Stickney. Shields Automatic Car Coupler Co., Marion, O.; capital stock, $10,000. Citizens' Gas Light Co., Willimantic, Conn.; capital stock, $50,000. Electric Railway Supply and Construction Co., Chicago, Ill.; capital stock, $100,000; incorporators; J M. Berenston, M. A. Berg and others. American Powder Co., Chicago, Ill.; capital stock, $1,500,000; incorporators: A. Tiarale, E. L. Kehans, F. E. Baker. C. W. Melcher Machinery Co., St. Louis, Mo.

Metal Market Prices.—*Rails.*—New York: $30.50 to $31; for old iron rails, $25.25 to $25.50. Chicago: $33.50; old rails, $26.50 to $27 for iron, $18.50 to $22 for steel. Pittsburg: $31.50 to $32.50; old rails, $28 for iron; $21.50 to $22.50 for steel.

Foundry Pig-iron.—Chicago: $15.50 to $17.50. Pittsburg: $15 to $17.50. New York: $16 to $18.

Track Materials.—New York: steel angle bars, $1.80 to $1.95; spikes, $2.20 to $2.25; track bolts, 2.95 to 3.10 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.95 to 2 cts. for iron, 2 to 2.1 cts. for steel; spikes, 2.15 cts.; track bolts, 2.85 with square, and 3 cts. with hexagon nuts. Chicago: splice bars, 2.25 cts. for steel, and 2 to 2.1 cts. for iron; spikes, 2.25 cts; track bolts 3.05 to 3.15 cts. with hexagon nuts.

Pipe.—Cast-iron, $27 to $30 per ton. Wrought iron, discounts as follows: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.55 to 4.65 cts.; Chicago, 4.65 to 4.7 cts.

Structural Material.—Pittsburg: angles, 2.2 to 2.25 cts.; tees, 2.8 to 2.85 cts.; beams and channels, 3.1 cts.; sheared steel bridge plates, 2.7 cts.; universal mill plates, 2.55 cts.; refined bars, 1.9 to 2 cts.; steel plates, 4.25 to 4.75 cts. for fire box; 3.2 to 3.25 cts. for flange; 3.05 cts. for shell, 2.7 to 2.75 cts. for tank. New York: beams, 3.10 cts.; plates, 2.15 to 2.20 cts.; angles, 2.25 cts.; tees, 2.5 to 2.6 cts.; channels, 3.1 cts. Chicago: angle, 2.35 to 2.4 cts.; tees, 2.8 to 2.9 cts.; beams, 3.2 cts.; universal plates, 2.45 to 2.55 cts.

New Water-Works, Atlanta, Ga.

Sealed proposals will be received at the Mayor's office in the city of Atlanta, Ga., until 12 o'clock meridian, on the 1st day of October, 1890, for furnishing material and constructing new water-works, approximately as follows:

One horizontal pumping engine, boilers, etc., with capacity of pumping 10 million gallons in 24 hours against a head of 235 feet.

One horizontal pumping engine, boilers, etc., with capacity of pumping 6 million gallons in 24 hours, against a head of 350 feet.

One filter plant of a capacity of filtering by gravity under a head of 20 feet, 3 million gallons in 24 hours.

Two engine houses and 2 smoke stacks.

One reservoir—62,000 cubic yards of earth excavation, 1,000 yards rock excavation, 10,000 brick laid, 50 cubic yards concrete.

One clear water basin—3,500 cubic yards earth excavation, 500 cubic yards of rock excavation, 450,000 brick laid, 400 square feet concrete.

Pumping well and intake—3,000 cubic yards of earth excavation, 1,000 cubic yards rock excavation, 200,000 brick laid and 100 cubic yards concrete.

Cast iron pipe and specials—

600 lineal feet of 36-inch pipe.
28,000 lineal feet of 30-inch pipe.
7,500 lineal feet of 20-inch pipe.

Valves, tees, crosses, valve boxes, etc.

Two pumping stations, consisting of 2 engine and 2 boiler rooms, one pumping well, one clear water basin and two brick chimneys.

Pipe laying—600 feet of 36-inch pipe, 28,000 feet of 30-inch pipe, 7,500 feet of 20-inch pipe, including valves, valve boxes and specials.

The above quantities and dimensions are to be considered approximate only, the committee reserving the right to increase or diminish as they may elect after receiving bids. Bids will be received for the whole or any particular branch or sub-division of the work.

Specifications and general plans can be seen at the office of the City Engineer or Superintendent of Water-works, Atlanta, Ga.

A certified check for $1,000 must accompany each bid, payable to John T. Glenn, Mayor, to be forfeited in the event of award and a failure to contract within 10 days. The right is reserved to reject any or all bids.

JNO. T. GLENN, Mayor.
R. M. CLAYTON, City Engr.
WM. G. RICHARDS, Supt. W. Wks.

36-4t

WRECK OF SCHOONER WEYBOSSET.—Engineer Office, U. S. Army, Newport, R. I., Aug. 27, 1890.—To whom it may concern.—Whereas, navigation is obstructed and endangered by the wreck of the schooner Weybosset, lying about 700 feet S. S. W. of the Bell Buoy north of Pollock Rip Light Ship; Notice is hereby given to all persons interested in said vessel, her cargo and all other property therein, that if, within thirty (30) days from the date of this advertisement, they shall have not signified to me their intention, and taken preliminary steps to remove said wreck, etc., as soon as practicable, the same will be considered as abandoned and derelict, and it will be removed by the United States under authority of law. Sealed proposals, in triplicate, for the removal of said wreck, will be received at this office until 12 o'clock, noon, on Friday, the 26th day of September, 1890, and then opened. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. The United States reserves the right to reject any or all proposals, and to waive any informalities. Full information furnished on application. By authority of the Secretary of War. W. B. LIVERMORE, Major of Engineers. 36-3t.

Notice to Bridge Builders.

AUGUSTA, Ga., Sept. 9, 1890.

Sealed bids for the erection of a wooden Howe truss highway bridge, pier and abutments, of two spans, 96 ft. each, for Broad St., over the first level of the canal, will be received at the above office till Sept. 20, at 12 noon, when they will be opened. Plans and specifications can be seen and all information secured at said office. Endorse envelope, "Bid for Bridge." The right is reserved to reject any and all bids. By order of Canal Committee.

A. H. DAVIDSON,
City Engineer.

37 1t

Wrought and Cast Iron Pipe.

Sealed proposals will be received by the Water Commissioners of Dalles City, Oregon, up to noon of October 8th, 1890 for furnishing about 208,000 lbs. of wrought iron pipe and about 170 tons of cast iron pipe and specials. Also for laying about 30,500 lin. ft. of pipe and building a receiving basin and a 3,000,000-gall. distributing reservoir.

Plans may be seen and specifications and forms of proposal obtained at the office of the Commissioner at The Dalles, Oregon.

G. P. LOW, Eng'r. M. T. NOLAN, Sec.

37-1t

S. E. NOBLE, Prest. JNO. E. WARE, Secy. and Treas. R. F. CARTER, Supt.

The Anniston Pipe Works,

MANUFACTURERS OF

CAST IRON WATER AND GAS PIPE,

ANNISTON, - - - - - ALA.

Especially adapted for the Elevation of Clear, Gritty, Thick, or Acidulous Liquids, Quickly, Cheaply and Efficiently

THE NEW PULSOMETER STEAM PUMP.

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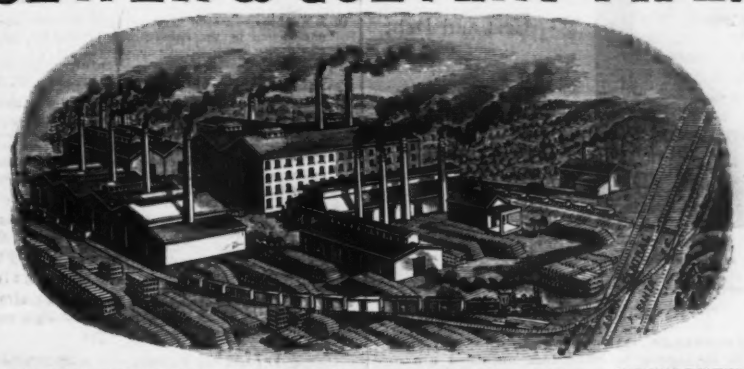
DOUBLE STRENGTH

SEWER & CULVERT PIPE.



MONMOUTH MINING & MFG. CO., MONMOUTH, ILL.

Fulton, Ky., Water-Works.

Sealed proposals will be received by the Mayor and Common Council of the City of Fulton, Kentucky, until 2 P. M., Wednesday, Oct. 1, 1890, for the construction of a system of water-works, according to plans and specifications for the same, which may be seen at the office of the City Clerk in said city, or at the office of the engineer, Geo. Cadogan Morgan, 15 Major block, Chicago.

Each and every proposal must be sealed and marked "Proposal for Water-Works," and must be filed with the City Clerk, at his office in said city, on or before the time stated above. Each and every proposal, to be in good form, must be accompanied with a clearing-house check, made payable to the City Treasurer of said city, for the sum of $250, as a guarantee of good faith, the same to be returned to the bidder submitting it when his proposal is rejected or when accepted, and a satisfactory bond deposited with the Mayor and Common Council.

The right is reserved by the city to make any additions to or deductions from the materials to be furnished or work done under the accepted proposal at a proportionate cost, to the amount of 15 per cent. of the same, at any time before the materials have been ordered or work done, and the right is still reserved to reject any and all bids.

ED. STARKS, Mayor.

By J. Robt. Nolen, C. C. F. 37-1t

Trenching and Water Pipe Laying.

Sealed proposals will be received by the Water Committee, South Orange, N. J., until Sept. 17 for excavating approximately five miles of trenches and laying cast-iron pipes therein; sizes ranging from 4 in. to 10 in. Contractor will deliver pipes, specials, valves, hydrants, etc., from the railroad cars to the trenches as located, will furnish yarn, lead and tools, and complete the mains ready for receipt of water. Specifications and plans may be seen at the office of the Engineer in charge of the work.

CARROL PH. BASSETT, M. Am. Soc. C.E.
784 Broad St., Newark, N. J.

H. H. HART,
H. B. HALSEY,
J. G. MORRISON, } Water Committee.

SOUTH ORANGE, Sept. 9, 1890. 37-1t.

Water-Works and Electric Light.

Special Council Proceedings.

Whereas, a petition largely signed by the tax payers and business men of the city of Canton, South Dakota, has been presented to the council asking for water-works and that an electric light plant be put in.

Therefore, be it resolved by the city council in adjourned session assembled, that the city will contract with any person or company for water and a sufficient number of hydrants to afford adequate fire protection, and for a sufficient number of electric lights to properly light the city, and to pay annual rental therefor sufficient to warrant the investment of the capital necessary to put in said plant.

Further, that it is the sense of the council that steps be at once taken to advertise for parties to take hold of the enterprise and invite bids and plans and specifications to that end.

Passed and adopted by an unanimous vote of the aldermen present, Sept. 3, 1890.

Attest J. M. ZELLER, Mayor.
O. T. OLEGAARD, City Clerk. 37-2t

Notice to Sewer Contractors.

IRON MOUNTAIN, Mich., Sept. 3, 1890.

Sealed proposals will be received at the office of City Clerk until noon, Sept. 20, 1890, for the furnishing of all material and the construction of about 7,000 feet of a main sewer.

All proposals must be signed by the bidder, and accompanied by a certified check for $200, made payable to City Treasurer of Iron Mountain, in case of failure to sign contract or to furnish satisfactory bond within three days from notification of the awarding of the contract.

The checks of unsuccessful bidders will be returned immediately after the contract is awarded or all bids rejected.

The right to reject any and all bids is reserved by Sewer Committee.

Plans and specifications can be had at office of City Engineer.

J. H. SANDUCOCK,
W. H. HANCOCK,
F. CARBIS,
C. FORELL,
W. H. SWEET, Ch'man.
Sewer Committee.

37-2t

Notice to Contractors for Water Works Plant.

OFFICE OF THE COMPTROLLER, CITY OF ALLEGHENY, Aug. 7, 1890.

Sealed proposals will be received at this office until 12 o'clock noon Wednesday, October 1, 1890, for doing the following work viz.:

PUMPING ENGINES.

For the construction and erection of two pumping engines of a capacity of 8,000,000 gallons each, to be of the type known as the vertical direct-acting three-cylinder compound condensing engines, with a combined capacity of pumping 16,000,000 gallons every 24 hours against a head of 300 feet, with a piston speed not exceeding 120 feet per minute.

RESERVOIRS.

For the construction of two basins having 460 by 660 feet surface at foot of embankments, said embankments to be 30 feet above bottom of basins. The reservoirs to have one inlet and one outlet gate chamber.

STOP GATES.

For furnishing six sixty-inch stop gates, to be doubled seated, with parallel-faced valves of easy adjustment, to be operated with two screw stems parallel to each other, and connected by suitable gear.

BOILERS.

For a 1,500 horse-power boiler plant; boilers to be set up in batteries not exceeding 300 horse power, with a given guarantee on evaporative power of boiler per pound of coal consumed. Boilers will be placed in position and set up by the contractor on foundations furnished by the city.

FILTERING PLANT.

Proposals will be received for the construction and erection of a filtering plant to be used in connection with new water service, to be erected at a point nine miles up the Allegheny River Bidders to furnish their own plans and specifications, erect their plants, and operate the same for a period of not less than six months on trial, and if satisfactory to the Committee on Water and Superintendent of Water-Works, the contract price to be paid; if not satisfactory, they to remove the plant without cost to the city.

CONDUIT AND FORCE MAINS.

For the construction and laying of a 60-inch steel or iron conduit from Nine-Mile island to the city, about 8.74 miles, to be in sections of 24 ft. in length from center to center of joints. Manholes to be provided for every 40 sections of water main. Elbows for vertical and horizontal inclinations to be provided for, with angles as shown on plan and profile. Force main to be fifty (50) inches in diameter, and constructed as per plans and specifications.

Plans and specifications for buildings, reservoirs, conduit force mains and delivery pipe will be furnished by the city.

Bidders will furnish their own plans and specifications in full detail for engines and boilers, and their connections, with necessary plans for foundations for same.

Proposals will be received for the construction of the whole work, or separately, as bidders may elect.

Plans and specifications may be seen and all information in regard to the above work can be obtained at the office of the Superintendent of Water-Works, and all correspondence in relation to the same should be addressed to Edward Armstrong, Superintendent, City Hall, Allegheny, Pa.

A bond must accompany each proposal to the full amount of the bid, with sufficient sureties for the faithful performance of the contract.

The right is reserved by the Committee on Water to accept or reject bids for the whole or any part of the above work.

JAMES BROWN,
Comptroller.

33-6t

To Architects.

SAGINAW, MICH., Aug. 31, 1890.

The City of Saginaw is about to construct a City Hall building at a cost not to exceed $110,000 exclusive of furnishing and heating.

1. You are invited to submit for the approval of the Common Council and Board of Public Works plans, specifications and drawings for such building on or before the 20th day of October, A.D. 1890.

2. Plans, specifications and drawings not approved will not be paid for.

3. The architect whose plans, specifications and drawings shall be adopted will be chosen to superintend the construction of the building and will be compensated therefor out of the proceeds of the sale of the bonds to be issued for said City Hall building. The compensation asked for the architect's work and superintendence shall be stated with the plans.

4. The architect chosen will be required to execute a bond to the city with sufficient sureties to be approved by the Common Council in the sum of $25,000 conditioned to secure to the city plans, specifications and drawings for said City Hall building, so accurately made that when the building is constructed in accordance therewith the cost of construction will not exceed the sum of $110,000 exclusive of furnishing and heating and to indemnify and save harmless the city for any error or inaccuracy in said plans, specifications and drawings, and against any negligence for failure on the part of such architect of any duty or obligation imposed upon him as superintendent of the construction of said building.

5. On application to the City Clerk blue prints of the location of the said proposed City Hall at corner of Washington avenue and Bristol street, and of suggested floor plans for said City Hall and any desired information will be furnished.

Very respectfully,

JOHN C. MATTHEWS,
City Clerk and Clerk of the Board.

37-2t

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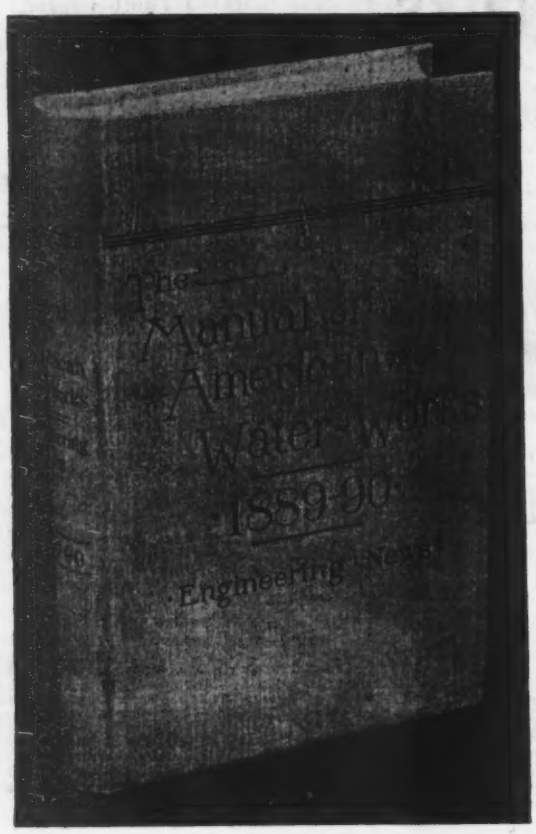

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DIRECTORY of Water-Works Officials, *with addresses.*
WATER RATES of 900 Cities and Villages in the United States.
ILLUSTRATIONS of notable Dams and Reservoirs.

M. N. BAKER, PH. B., EDITOR.

961 JACKSON ST., OAKLAND, Cal., Aug. 27, 1890.

Your "Manual of American Water-Works 1889-'90" came to hand last night. I am extremely pleased with it and you deserve great credit for carrying out successfully such a laborious undertaking.

L. J. LECONTE.

BALTIMORE, Aug. 27, 1890.

I think it is better every year. ROBERT K. MARTIN, Chief Engr. Water Dept.

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FOR SALE.

No. 2 Gates Stone Crusher, nearly new.

Address O. C. LE SUER,

37-2t Lawrence, Kans.

To Manufacturers of Pumping Machinery.

Sealed proposals will be received at the office of the City Secretary of the City of Dallas, Tex., until 6 o'clock P. M., Wednesday, Sept. 24, 1890, for constructing and placing in position in the pumping station at Turtle Creek in said city one 10,000,000-gall. vertical compound condensing pumping engine. Proposals will also be received at the same time for furnishing and setting up at the same pumping station two (2) 60-in. by 16-ft. return tubular steel boilers and five (5) new boiler fronts

All to be in accordance with general plans and specifications on file with the City Secretary. Certified checks to accompany bids as follows: With bid on pump, check for $2,500, and with bid on boilers a check for $500. The city reserves the right to reject any or all bids.

36-2t W. McGRAIN, City Secretary.

Artesian Well.

Sealed proposals will be received by the undersigned at the City Hall, Galveston, Texas up to 12 o'clock, noon, of Thursday, Sept. 25, A. D., 1890, for the boring of an artesian well, in the City of Galveston, to a depth of 3,000 ft., unless satisfactory water is procured at a lesser depth. Bidders to give price per foot for finishing with 6-in., 8-in., 10-in. and 12-in. pipe respectively. The right to reject any or all bids is reserved. THOS. W. JACKSON,

35-5t Chairman of Special Committee.

Earth Work Slips and Subsidences upon Public Works, their causes, prevention and reparation. Especially written to assist those engaged in the construction or maintenance of Railways, Ditches, Canals, Roads, Water-Works, River Banks, Reclamations, Embankments, etc., etc. By John Newman, 12mo, cloth. London, 1890. $3.00.

For sale by ENGINEERING NEWS PUB. CO.

TO LET.

The laying of 1,400 cu. yds. Heavy Granite and Limestone Masonry in Mississippi River at this place. Will furnish material and plant to right man.

McCORMICK & O'MEARA,

33- 904 Olive St., St. Louis, Mo.

CONTRACTORS' PLANT

For Sale Cheap.

A quantity of 6, 10 and 12-in. CAST-IRON PIPE, R. D. Wood & Co. make, tested to Government standard and weights; has been used only to convey compressed air and is good as new. Also a quantity of WROUGHT-IRON PIPE 1, 2, 3 and 4 in., in good order, besides COMPRESSOR, BOILER, ENGINE, DERRICKS, 3 KNOWLES STEAM PUMPS STEAM BOILER, ONE STEAM SHOVEL, and a large amount of CONTRACTORS' PLANT. For particulars, price, etc., inquire of

BECKWITH, QUACKENBUSH, & CO.,

2,925 M. St., N. W., Georgetown, D. C.

Holmes' Flexible Joint.

I have perfected and patented the best flexible joint for water pipes, gas pipes, steam pipes, compressed air pipes, oil, etc., etc., for use with either cast or wrought pipe, flanged, head or screw joints, easily attached and detached, and by its use pipes can be connected at any angle without trouble and with the least amount of friction possible. It will allow of more movement in any direction than any other joint without leaking, and is very reasonable in price.

Correspondence solicited.

A. L. HOLMES,

Grand Rapids, Mich.

SITUATIONS VACANT.

WANTED—A trackmaster of experience. A liberal salary will be paid. Apply by letter, giving references, to TRACKMASTER, care of Engineering News. 34-4t

WANTED.—A sober, good-tempered, experienced engineer to take charge of erection and operation of rock drills, air compressors, Corliss engines and general machinery in a mine in a foreign country; must be experienced with Ingersoll-Sergeant machinery; contract for one year, with privilege of renewal; pay $5 per day and expenses, including board and lodging; only experienced men, highly recommended, will be considered. Address WILLIAM L. SAUNDERS, 10 Park Place, New York. 34-4t

WANTED.—A well recommended young man of good character, ability and temper, and a neat draughtsman and penman, having had some field or office experience and one or more years study in engineering school can have an opportunity of paying his board and also his tuition, in a leading southern engineering school having extensive facilities for instruction, by giving a moderate amount of general assistance in a private engineering office. Some shorthand ability preferred Address, O. H. L., care Engineering News. 36-2t

WANTED.—A French engineering firm in this city wants to engage an engineer as "Clerk of Works" on a large manufactory being built by them in Newark, N. J. The indispensable requirement is a familiar knowledge of French, so that the instructions of the constructing engineers can be fully comprehended. The duties of the assistant are to simply see that the instructions given him are carried out. Applications must be in French, and as the place must be filled without delay, letters arriving later than Wednesday morning, Sept. 17, will not be considered. Address or call at office of BUSINESS MANAGER of this paper. 37-1t

WANTED.—A civil engineer with several years' experience in the construction of bridges, cable roads, city and hydraulic engineering, is now open for engagement. Have a good outfit. Please address JAMES KELLEY, South Syracuse, N. Y. 37-1t

WANTED.—A college educated draughtsman with experience in designing and building automatic compound steam engines, vertical and horizontal, can find employment with a large engineering establishment in Pennsylvania. Address M. F. S., Engineering News. 37-2t

WANTED.—A surveyor to take charge of party in city and country work. Salary $80 a month Also a transitman and chainman. Address, stating qualifications, CIVIL ENGINEER, care of Engineering News. 37 2t

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PROPOSALS FOR LOCK CONSTRUCTION. Engineer's Office, U. S. Army, Nashville, Tennessee, August 18, 1890. Sealed proposals, in triplicate, will be received at this office until 3 P. M. Tuesday, September 23, 1890, for part construction and completion of Lock No. 1, Cumberland River, near Nashville, Tennessee. Bidders are invited to be present at opening of the bids. The United States reserves the right to reject any and all proposals. The attention of bidders is invited to the acts of Congress, approved February 26, 1885, and February 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at Large. Specifications and blank forms for proposals will be furnished on application at this office. J. W. BARLOW, Lieut. Col. of Engineers. 35-4t

PROPOSALS for furnishing and placing stone on breakwater at Bar Harbor, Maine. United States Engineer's Office, Portland, Maine, Aug. 25, 1890. Sealed proposals in triplicate for furnishing and placing stone on the breakwater at Bar Harbor, Maine, will be received at this office, No. 537 Congress St., until 3 P. M., of Thursday, Sept. 25, 1890, and then opened. Attention is invited to Acts of Congress, approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 414, Statutes at Large. All necessary information furnished on application to JARED A. SMITH,

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IMPROVEMENT OF PHILADELPHIA HARBOR. U. S. Engineer Office, 1428 Arch street, Philadelphia, Pa., Aug. 16, 1890. Sealed proposals, in duplicate, will be received at this office until 11 A. M. Tuesday, Sept. 16, 1890, and then opened, for dredging in Philadelphia Harbor, Pa., for removal of Smith's and Windmill Islands. The attention of bidders is invited to the Acts of Congress approved Feb. 26, 1885, and Feb. 23, 1887, Vol. 23, page 332, and Vol. 24, page 414, Statutes at large. For all information apply to C. W. RAYMOND, Major of Engineers, U. S. Army

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